Allen-Bradley

Bulletin 1404 Powermonitor 3000

1404-M4, 1404-M5, 1404-M6, 1404-M8

User Manual

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.ab.com/manuals/gi) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations.

WARNING

Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

ATTENTION

Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you:

- identify a hazard
- avoid a hazard
- recognize the consequence

SHOCK HAZARD

Labels may be located on or inside the drive to alert people that dangerous voltage may be present.

BURN HAZARD

Labels may be located on or inside the drive to alert people that surfaces may be dangerous temperatures.

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Using This User Manual

What This User Manual Contains

Review the table below to familiarize yourself with the topics contained in this User Manual.

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What This User Manual Does Not Contain

Topics related to installation and wiring are not covered in this manual. Refer to the Powermonitor 3000 Installation Instructions, publication 1404-IN007 for the following information:

- Selecting an enclosure for the Powermonitor 3000 and associated equipment.
- Mounting and wiring of the Master Module.
- Mounting and connection of the Display Module (refer to publication 1404-IN005).
- Selection and connection of current transformers (CTs) and potential transformers (PTs)
- Wiring to native and optional communications ports.

For More Information on Additional Power and Energy Management Products

For this information:	**Refer to Publication**
Powermonitor 3000 Installation Instructions (all communication options)	1404-IN007
Bulletin 1404 Powermonitor 3000 Display Module Installation Instructions	1404-IN005
Bulletin 1404 Series B Ethernet Communications Release Note	1404-RN008
Bulletin 1403 Powermonitor II Tutorial	1403-1.0.2
Bulletin 1403 Powermonitor II Instruction Sheet	1403-5.0
Cat. No. 1403-NSC Smart Communications Card Instruction Sheet	1403-5.1
Cat. No. 1403-NENET Ethernet Communications Card Instruction Sheet	1403-IN005
Cat. No. 1403-NDNET DeviceNet Communications Card Instruction Sheet	1403-IN054
Cat. No. 1402-LS51 Installation and Operation Manual	1402-5.0
Cat. No. 1407-CGCM User Manual	1407-UM001
Bulletin 9307 RSPower32	P32-TD001
Bulletin 9307 RSEnergyMetrix	ENEMTX-TD 001

Terms and Conventions

In this manual, the following terms and conventions are used:

Abbreviation	Term
AWG	American Wire Gage
BSD	Berkeley Sockets Distribution
BTR	Block Transfer Read
BTW	Block Transfer Write
CSA	Canadian Standards Association
CIP	Control and Information Protocol
CNET	ControlNet Industrial Control Network
CT	Current Transformer
DC	Daughter Card
DM	Display Module
DPRAM	Dual Port RAM
EMI	Electromagnetic Interference
EOI	Rockwell Automation's *Electronic Operator Interface* group
HTML	Hyper-Text Markup Language
ID	Identification
I/O	Inputs and Outputs
IEC	International Electrotechnical Commission
LED	Light Emitting Diode
LSM	Line Synchronization Module
NEMA	National Electrical Manufacturers Association
NAP	Network Access Port
NVS	Non-Volatile Storage
EtherNet/IP	Open Device Vendor's Association's Ethernet Industrial Protocol
PT	Potential Transformer (Also known as VT in some countries)
PM 3000	Powermonitor 3000 Master Module
PLC	Programmable Logic Controller
RFI	Radio Frequency Interference
RAM	Random Access Memory
RTOS	Real Time Operating System
R I/O	Remote Input/Output
PCCC	Rockwell Automation's proprietary *Programmable Controller Communications Commands* protocol.
RMS	Root–mean–square
SNTP	Simple Network Time Protocol

Abbreviation	Term
SPDT	Single Pole Double Throw
SLC	Small Logic Controller
trrbl	“Task Request Response Block” used by RTOS for inter-task communication
UL	Underwriters Laboratories
VA	Volt–ampere
VAR	Volt–ampere Reactive

Safety

Safety Considerations

Before installing and using this product, please read and understand the following precautions.

ATTENTION

Only qualified personnel, following accepted safety procedures, should install, wire and service the Powermonitor 3000 and its associated components. Before beginning any work, disconnect all sources of power and verify that they are de-energized and locked out. Failure to follow these instructions may result in personal injury or death, property damage or economic loss.

ATTENTION

Never open a current transformer (CT) secondary circuit with primary current applied. Wiring between the CTs and the Powermonitor 3000 should include a shorting terminal block in the CT secondary circuit. Shorting the secondary with primary current present allows other connections to be removed if needed. An open CT secondary with primary current applied produces a hazardous voltage, which can lead to personal injury, death, property damage or economic loss.

IMPORTANT

The Powermonitor 3000 is not designed for nor intended for use as a circuit protective device. Do not use this equipment in place of a motor overload relay or circuit protective relay.

IMPORTANT The relay output contacts and solid-state KYZ output contacts on the Powermonitor 3000 may be used to control other devices through setpoint control or communications. The response of these outputs to a communications failure is configurable by the user. Be sure to evaluate the safety impact of the output configuration on your plant or process.

Other Precautions

ATTENTION

Electrostatic discharge can damage integrated circuits or semiconductors. Follow these guidelines when you handle the module.

- Touch a grounded object to discharge static potential.
- Wear an approved wrist strap-grounding device.
- Do not open the module or attempt to service internal components.
- If available, use a static safe workstation.
- When not in use, keep the module in its static shield bag.

Product Description

The Bulletin 1404 Powermonitor 3000™ is uniquely designed and developed to meet the needs of both producers of and users of electric power. A Powermonitor 3000 system consists of:

- *Master Module* which provides metering, data logging, native RS-485 communications and other advanced features depending on the model
- Optional *Display Module* for configuration, entering commands and displaying data
- Optional communications port to serve data to other devices using a choice of networks
- Optional external devices and applications that display and utilize data for reporting, control and management of power and energy usage

The Powermonitor 3000 is a microprocessor-based monitoring and control device ideally suited for a variety of applications including:

- *Load Profiling* – Using the configurable trending utility to log power parameters such as real power, apparent power and demand, for analysis of power usage by loads over time
- *Demand Management* – Understanding when and why demand charges occur lets you make informed decisions that reduce your electrical power costs
- *Cost Allocation* – Knowing your actual energy costs promotes manufacturing efficiencies
- *Distribution System Monitoring* – Using power parameters to show power flow, system topology and distribution equipment status
- *Emergency Load Shedding* – Monitoring power usage to preserve system stability in the event of sudden utility outage
- *Power System Control* – Managing system voltage, harmonic distortion and power factor

The Powermonitor 3000 is a sophisticated modern alternative to traditional electromechanical metering devices. A single Powermonitor 3000 can replace many individual transducers and meters. The Powermonitor 3000 is simple to install, configure and operate, and provides you with accurate information in a compact economical package.

Master Module

The Master Module contains the main microprocessor-based monitoring functions, including terminations for power system connections, status inputs, control outputs, a native RS-485 communications port and a port for the Display Module.

Configuration

Although the Powermonitor 3000 ships from the factory with default settings, you need to configure it for your particular requirements. You may configure the Powermonitor 3000 using the optional Display Module. Alternately, you may use an external device or application to write configuration, operational parameters and commands to the Master Module through its native or optional communications port.

Optional external applications that you may use for Powermonitor 3000 configuration include RSPower32™ and RSEnergyMetrix™ software operating on a computer with a Microsoft Windows™ operating system. Contact your local Rockwell Automation sales office or distributor, or visit http://www.software.rockwell.com/ for more information on available software packages.

Communications

Every Powermonitor 3000 comes with a native RS-485 communications port that supports the Allen-Bradley DF1 half-duplex slave and Modbus RTU slave protocols. The native port is suitable for communicating to master devices including:

- A-B PLC®-5, SLC™ 500 and ControlLogix processors
- RSLinx™ software with DDE/OPC server functionality
- Modbus RTU masters
- Other third-party devices
- Software that you develop

You may also specify Powermonitor 3000 units with optional communications ports including:

- Serial RS-232 (DF1 half-duplex or Modbus RTU slave)
- Remote I/O
- DeviceNet™
- Ethernet® and EtherNet/IP™
- ControlNet™

You may easily integrate a Powermonitor 3000 into a programmable controller based control and monitoring system using your choice of the native or optional communications methods listed above.

Display Module

The Bulletin 1404 Display Module is an optional user interface device. The Display Module provides the most economical and simplest method for setting up and configuring the Master Module for operation.

The Display Module has a highly visible, two-line LED display and four operator buttons with tactile feedback. Use the buttons and display to navigate through a series of menus for configuration, commands and data display.

The Display Module is shipped with a 3-meter (10-ft.) long, shielded 4-pair cable that provides power and serial communications between the Master Module and the Display Module. The Display Module fits into a standard ANSI 4-inch analog meter cutout for panel mounting. Only one Display Module may connect to a Master Module, although you may use one Display Module to configure and monitor any number of Master Modules one at a time.

Performance Features

The Powermonitor 3000 is available in four basic models, designated M4, M5, M6 and M8. Each model offers specific functionality as indicated in the table below. The M5 model offers M4 functionality and can be field-upgraded to an M6 or M8 model for an additional charge.

Table 2.1 Product Features of Powermonitor 3000 Module

M4	M5	M6	M8	Master Module Features
•	•	•	•	Voltage, current, power measurements and display
•	•	•	•	Compatible with PLC-5, SLC 500, and ControlLogix
•	•	•	•	Compatible with RSLinx, RSPower32, RSEnergyMetrix and RSView32
•	•	•	•	Output control via control relays or PLC
•	•	•	•	Demo mode for training
•	•	•	•	10 user configurable setpoints
•	•	•	•	Discrete condition monitoring via status inputs
•	•	•	•	Electronic KYZ pulse output
•	•	•	•	Form C ANSI C37.90-1989 rated relay for direct breaker tripping
•	•	•	•	Time stamped data logging of system measurements and events
•	•	•	•	Configurable trend log, up to 45,000 records deep
•	•	•	•	Event log 50 records deep
•	•	•	•	Firmware upgrades without removing module
•	•	•	•	Total harmonic distortion (THD) and Crest Factor
•	•	•	•	Automatic network-based time synchronization via SNTP (for Ethernet Series B)
•	•	•	•	Daylight Savings Time (Master Module FRN 2.5x)
	•	•	•	ANSI C12.20 Class 0.5 revenue metering accuracy(1)
	•	•	•	EN60687 Class 0.5 revenue metering accuracy(1)
	•	•	•	Canadian Revenue Meter specification accuracy
	•	•	•	Field upgradeable to M6 or M8 (extra cost option)
		•	•	10 additional setpoints with more options
		•	•	Event Log an additional 50 records deep
		•	•	User configurable oscillography up to 400 cycles @ 60 Hz
		•	•	TIF, K-factor and IEEE-519 Pass/Fail
		•	•	Sag and swell detection with oscillogram capture
		•	•	Load factor log 12 records (months) deep
		•	•	Calculates amplitude and % distortion for harmonics 1 to 41
			•	Calculates amplitude and % distortion for harmonics 1 to 63
			•	Sub-cycle transient capture and metering
			•	Event Log with user comment entry
			•	Transducer and Energy Meter modes with improved update rate

(1) Class 0.2 revenue metering accuracy available as an extra-cost option.

Communications Options

In addition to the native RS-485 communications port, several factory-installed communications options are also available. These options make is possible for a user to select Powermonitor 3000 units to provide power and energy information into a variety of existing or new control systems and communications networks. Each communications option supports bi-directional data transfer with external devices or applications. Metering measurement, logging, configuration and status data may be accessed via communications.

Communications options are set in the Master Module. You may configure communications using the Display Module or via communications to an external application such as RSPower32 or RSEnergyMetrix. Refer to the information later in this manual on configuration and operation of the communications options.

Refer to the Powermonitor 3000 Installation Manual (publication 1404-IN007) for installation and wiring information related to your selected communications options.

The last 3 characters of the catalog number specify the communications option of the Powermonitor 3000.

RS-485 Native Communications

A catalog number ending in -000 specifies a Powermonitor 3000 equipped with only a native RS-485 communications port with the following performance features:

- Baud rates 1200, 2400, 4800, 9600, 19,200
- RS-485 cable length 1219 m (4000 ft) at 19,200 baud maximum
- Cable type: 2-wire shielded (Belden™ 9841)
- Multi-drop capabilities up to 32 nodes
- Update rate: 100 mSec minimum
- Read/Write data table access to all data
- One user-configurable data table
- Supports DF1 half-duplex and Modbus RTU communications protocol
- Used for field firmware upgrades

RS-232 Optional Communications

A catalog number ending in -232 specifies a Powermonitor 3000 with one RS-232 communications ports in addition to the native RS-485 communications port. The user selects which of the two ports is active, as the two ports may not be used concurrently. The RS-232 port has the following performance features:

- Baud rates 1200, 2400, 4800, 9600, 19,200
- RS-232 cable length 15.24 m (50 ft) maximum
- Cable type: 3-wire shielded (Belden 9608)
- Point-to-point wiring
- Update rate: 100 mSec minimum
- Read/Write data tables for access to all data
- One user-configurable data table
- Supports DF1 half-duplex slave communications protocol
- Supports Modbus RTU slave protocol

Remote I/O Optional Communications

A catalog number ending in -RIO specifies a Powermonitor 3000 with a Remote I/O communication port in addition to the native RS-485 communications port. The Remote I/O option permits concurrent use of both communications ports. The Remote I/O port has the following performance features:

- One-quarter rack slave device
- Three baud rates: 57.6k, 115.2k, 230.4k
- Cable lengths up to 3048 meters (10,000 feet)
- Node capacity up to 32 nodes
- Update rates for discrete I/O: 5 mSec
- Update rates for block transfers: 50 mSec minimum
- Two discrete inputs
- Eleven discrete outputs
- Read/Write block transfer data tables for access to all data

DeviceNet Optional Communications

A catalog number ending in -DNT specifies a Powermonitor 3000 with a DeviceNet port in addition to the native RS-485 port. The DeviceNet option permits concurrent use of both communications ports. The DeviceNet port has the following performance features:

- Adapter class device
- Four baud settings: 125k, 250k, 500k and AutoBaud
- Remotely settable baud rate
- Cable length up to 500 meters maximum
- Node capacity up to 64 nodes including master
- Remotely settable node address
- Shielded twisted-pair media containing both signal and power conductors
- Update rates for I/O channel: 100 mSec minimum
- Update rates for explicit messaging: 250 mSec minimum
- Configurable I/O channel assembly instance: six parameters default, twenty-three maximum
- Configurable explicit assembly instance: seventeen parameters default, twenty-three parameters maximum
- Explicit assembly instances for access to all data
- Two I/O assembly instances
- May be reset remotely through Identity Object
- Support for up to four concurrent clients
- Supports DeviceNet heartbeat facility

Ethernet Optional Communications

A catalog number ending in -ENT specifies a Powermonitor 3000 with one active 10BaseT Ethernet communication port in addition to the native RS-485 port. The Ethernet port has the following performance features:

- Connect to Allen-Bradley PLC-5E, SLC 5/05, ControlLogix Ethernet Bridge and the 1761-NET-ENI module products
- Built-in Internet web page support
- Compatible with RSPower32, RSEnergyMetrix, RSView32 and RSTrend™ software
- Ethernet communication rate: 10Mbps (Series A)
  10/100Mbps (Series B)

- Compatible with commercially available network bridges, routers, hubs and switches
- Fully software configurable
- Supports RSLinx (Series A emulates SLC 5/03+ with Ethernet; Series B emulates a ControlLogix Ethernet Bridge)
- Supports Allen-Bradley Client Server Protocol (CSP)
- Supports EtherNet/IP (CIP) protocol
- Configurable I/O channel assembly instance: six parameters default, twenty-three maximum
- Configurable explicit assembly instance: seventeen parameters default, twenty-three parameters maximum
- Explicit assembly instances for access to all data
- Two I/O assembly instances
- Remotely resettable through Identity Object
- Supports up to 64 CIP/HTTP concurrent connections
- Data read latency: less than 10 mSec
- Update rates for real-time metering data: 100 mSec minimum
- Update rates for logged data: 250 mSec minimum
- Supports Allen-Bradley pass-thru communications
- Supports network-based time synchronization via SNTP (Series B)
- Supports networked demand period synchronization (Series B)
- Supports Class 1 scheduled connection for I/O data (Series B)

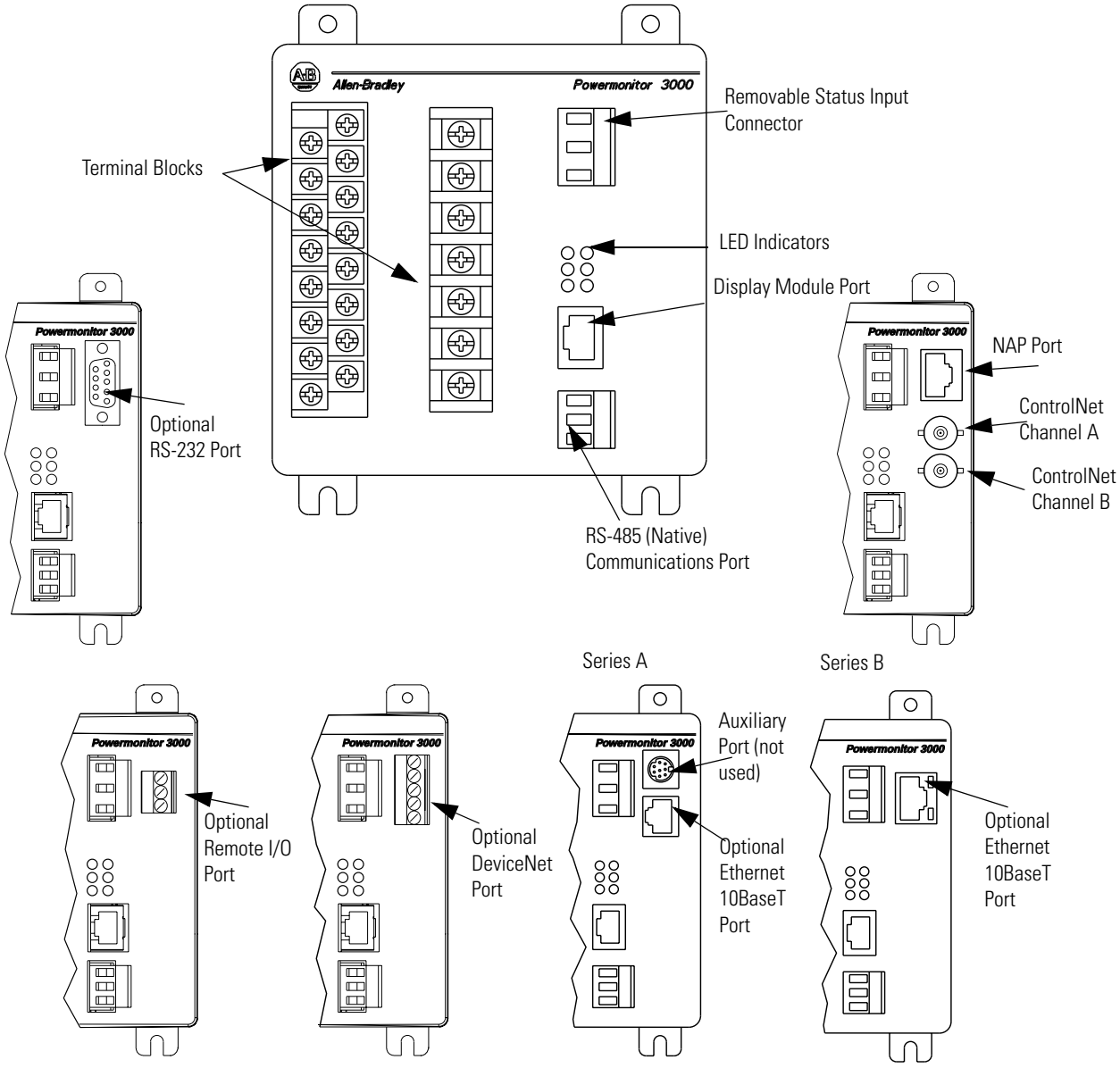
ControlNet Optional Communications

A catalog number ending in -CNT specifies a Powermonitor 3000 with a ControlNet communications interface in addition to the native RS-485 port. The ControlNet interface has the following features:

- Adapter class device
- Supports redundant media or single media applications; physical connections include NAP port and two BNC connectors
- ControlNet International conformace tested and approved
- Compatible with ControlLogix, PLC5, SLC, PanelView, RSEnergyMetrix, RSPower32 and more
- All Powermonitor data readable/writable via unscheduled (UCMM or Class 3) connection to Powermonitor assembly object instances 3-64

- Supports scheduled messaging (Class 1 connection); one assembly instance of configurable content from the Powermonitor and one assembly instance of fixed content to the Powermonitor
- Supports up to 64 concurrent Class 1 connections to instance 1 and one Class 1 connection to Instance 2.
- ControlFLASH can be used to update ControlNet communication firmware
- Supports ControlLogix message types: CIP Generic, PLC5 Typed
- Set Powermonitor node address (MAC ID) via Display Module, native comm port, or ControlNet assembly instance 12

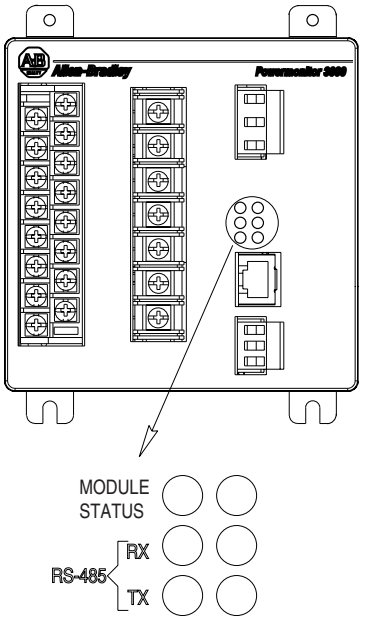
Figure 2.1 Master Module with Various Communications Options



LED Indicators

The Powermonitor 3000 is equipped with six, 2-color light emitting diodes (LEDs) arranged as shown in Figure 2.2. Functions of the LEDs differ among the various communications configurations.

Figure 2.2 LED Indicators



The three LED's on the left display the same information on Powermonitor 3000 modules with any communication option including native RS-485 communications only. The three LED's on the right have different labels and different indications depending on the communications option selected, as shown in the chart below.

Table 2.2 LED Indicators All Powermonitor 3000 Models

LED	LED Color	LED State and Communications Condition
Module Status	Off	Control power is off or insufficient
	Steady Red	Major fault; internal self-test has failed. If a power cycle does not correct the problem, call customer support
	Steady Green	Powermonitor 3000 is operating normally
RS-485 RX	Off	The RS-485 bus is idle; no active data is present
	Flashing Green	Active data is present on the RS-485 bus
RS-485 TX	Off	Powermonitor 3000 is not transmitting data onto the RS-485 bus
	Flashing Green	Powermonitor 3000 is transmitting data onto the RS-485 bus

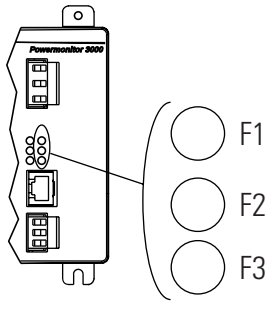


Table 2.3 Native RS-485 Communications only (catalog numbers ending in -000)

LED	LED Color	LED State and Communications Condition
F1	Off	Not Used
F2	Off	Not Used
F3	Off	Not Used

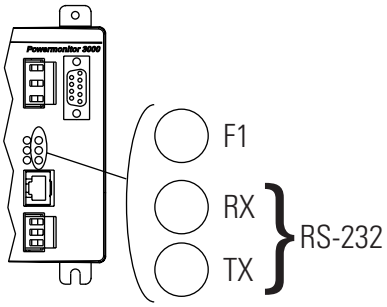


Table 2.4 RS-232 Optional Communications (catalog numbers ending in -232)

LED	LED Color	LED State and Communications Condition
F1	Off	Not Used
RS-232 RX	Off	The RS-232 bus is idle; no active data is present
	Flashing Green	Powermonitor 3000 is receiving data.
RS-232 TX	Off	The Powermonitor 3000 is not transmitting any data onto the RS-232 bus
	Flashing Green	The Powermonitor 3000 is transmitting data.

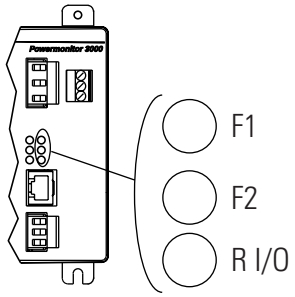


Table 2.5 Remote I/O Optional Communications (catalog numbers ending in -RIO)

LED	LED Color	LED State and Communications Condition
F1	Off	Not Used
F2	Off	Not Used
R I/O	Off	Remote I/O communications has not been established
	Flashing Green	Remote I/O communications has been established but there are errors
	Steady Green	Remote I/O communications has been established

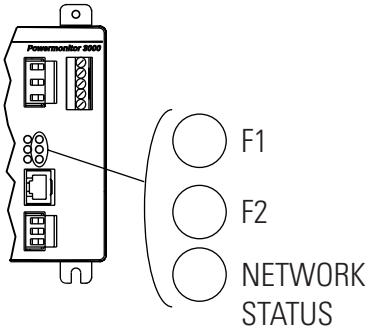


Table 2.6 DeviceNet Optional Communications (catalog numbers ending in -DNT)

LED	LED Color	LED State and Communications Condition
F1	Off	Not Used
F2	Off	Not Used
Network Status	Off	Power is off or the Powermonitor 3000 is not online
	Flashing Green	Network status is OK, no connections established
	Steady Green	Network status is OK, connections established
	Flashing Red	Recoverable communications failure; port is restarting
	Steady Red	Non-recoverable communications error; check wiring and configuration parameters

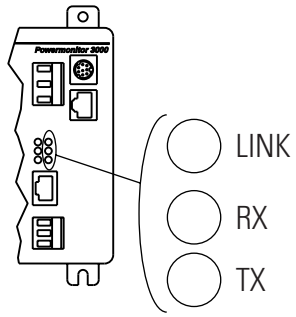


Table 2.7 Ethernet Optional Communications (Series A catalog numbers ending in -ENT)

LED	LED Color	LED State and Communications Condition
Link	Off	Ethernet connection is inactive
	Steady Green	Ethernet connection is active
RX	Off	Ethernet is idle, no active data present on port
	Flashing Red	Active data is present on Ethernet port
TX	Off	Powermonitor 3000 is not transmitting any data through the Ethernet port
	Flashing Red	Powermonitor 3000 is transmitting data

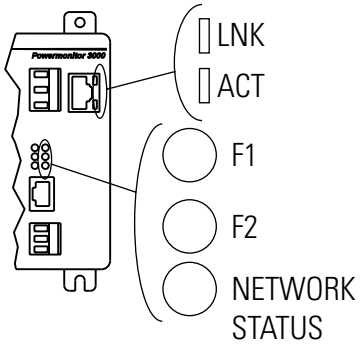


Table 2.8 EtherNet/IP Optional Communications (Series B catalog numbers ending in -ENT)

LED	LED Color	LED State and Communications Condition
LNK	Off	No valid physical Ethernet connection
	Steady Green	Valid physical Ethernet connection
ACT	Strobing or Solid Yellow	Powermonitor 3000 transmitting onto Ethernet
F1	Off	Not Used
F2	Off	Not Used
NETWORK STATUS	Off	No power
	Flashing Green	No established connections
	Steady Green	Connected; has at least one established connection
	Flashing Red	Connection timeout; one or more connections to this device has timed-out
	Steady Red	Duplicate IP; the IP address assigned to this device is already in use
	Flashing Green/Red	Selftest; this device is performing a power-up self test

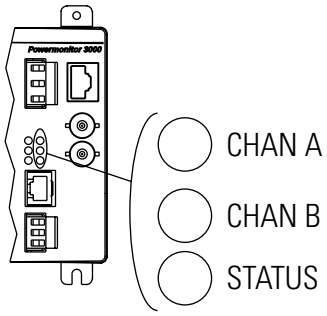


Table 2.9 ControlNet Optional Communications (catalog numbers ending in -CNT)

LED	LED Color	LED State and Communications Condition
CHAN A and CHAN B	Off	No power or Channel disabled
	Steady Red	Faulted unit
	Alternating red/green	Self-test
	Alternating red/off	Incorrect node configuration
	Steady green	Normal operation
	Flashing green/off	Temporary errors or node is not configured to go on-line
	Flashing red/off	Media fault or no other nodes present on network
	Flashing red/green	Incorrect network configuration
Status	Steady Green	Normal operation
	Flashing green/red	Communication card power-up self-test

Powermonitor 3000 Operations

The Powermonitor 3000 is a microprocessor-based electrical power- and energy-measuring device. It connects to the user's three-phase or single-phase AC power system directly or through instrument transformers (PTs and CTs). It converts instantaneous voltage and current values to digital values, and uses the resulting digital values in calculations of voltage, current, power, energy, etc. You may access the resulting metering values manually using the Display Module or automatically using communications with an external device or application.

The basic operations of the Powermonitor 3000 include the following:

- Metering functionality
- Operational and status indication
- Operation of the Display Module
- Display Module menus and parameter structure
- Setup and configuration using the Display Module
- Data monitoring using the Display Module
- Issuing commands using the Display Module

Other Powermonitor 3000 features such as communications, setpoint operations, I/O operations, data logging, oscillography, harmonics, sag/swell detection, load factor calculation and transient detection will be covered later in this manual.

Metering Functionality

The Powermonitor 3000 performs calculations on scaled, digital voltage and current values. Signals connected to the voltage and current inputs are sampled and their instantaneous values are converted to digital values in an analog-to-digital (A/D) converter section. These values are scaled according to configured PT Primary, PT Secondary, CT Primary and CT Secondary parameters, and evaluated according to the configured Wiring Mode parameter. Metering results are available for display on the Display Module, in the communications data tables and for use in setpoint programming and data logging. Table 3.1 provides a summary of measurements produced in each Powermonitor 3000 model, and notes which measurements you may view using the Display Module.

Table 3.1 Summary of Measurements

M4 M5	M6	M8	DM[1]	Measurement
•	•	•	•	Current, per phase and neutral
•	•	•	•	Average current
•	•	•	•	Positive sequence current
•	•	•	•	Negative sequence current
•	•	•	•	Percent current unbalance
•	•	•	•	Voltage per phase L-L, and L-N on 4-wire systems
•	•	•	•	Average voltage per phase L-L, and L-N on 4-wire systems
•	•	•	•	Positive sequence voltage
•	•	•	•	Negative sequence voltage
•	•	•	•	Percent voltage unbalance
•	•	•	•	Frequency
•	•	•	•	Phase rotation (ABC, ACB)
•	•	•	•	Real power (watts), total and per phase on 4-wire systems
•	•	•	•	Reactive power (VARs), total and per phase on 4-wire systems
•	•	•	•	Apparent power (VA), total and per phase on 4-wire systems
•	•	•	•	True power factor (PF), total and per phase on 4-wire systems
•	•	•	•	Displacement PF, total and per phase on 4-wire systems
•	•	•	•	Distortion PF, total and per phase on 4-wire systems
•	•	•	•	Energy consumption in kilowatt-hours (kWh), forward, reverse, and net
•	•	•	•	Reactive energy consumption in kVAR-hours, forward, reverse, and net
•	•	•	•	Apparent energy consumption in kVA-hours
•	•	•	•	Current consumption in ampere-hours
•	•	•	•	Demand (kA, kW, kVAR, and kVA)
•	•	•	•	Projected demand (kA, kW, kVAR, and kVA)
	•	•	•	Load factor calculation (amps, watts, VAR, and VA)
•	•	•	•	IEEE percent THD (total harmonic distortion)
•	•	•	•	IEC percent THD (Distortion Index) (DIN)
•	•	•	•	Crest Factor
	•	•	•	TIF (Telephone Interference Factor)
	•	•	•	K-factor
	•	•	•	IEEE 519 TDD (total demand distortion)
	•	•	•	IEEE 519 pass/fail calculation on voltage and current
	•	•		Individual percent and RMS magnitude, harmonics 1 - 41
		•		Individual percent and RMS magnitude, harmonics 42 - 63
	•	•		Oscillography capture data
		•		Transient voltage and current index
		•		RMS voltage and current per phase for each cycle of transient capture
		•		Transient capture wave form data

(1) If this box is checked, you may view the measurement using Display Module. If not, you may access measurements using communications only.

Metering Accuracy Class

Table A.16, element 26 is a read-only parameter that indicates the revenue metering accuracy class of the Master Module. If this element contains the value 0, the Master Module meets ANSI C12.16 and EN61036 Class 1 requirements for accuracy. If this element contains the value 1, the Master Module meets ANSI C12.20 Class 0.5, EN60687 Class 0.5, and Canadian standard CAN3-C17-M84 requirements for accuracy. If this element contains the value 2, the Master Module meets ANSI C12.20 Class 0.2, EN60687 Class 0.2, and Canadian standard CAN3-C17-M84 requirements for accuracy. The revenue metering accuracy class is also indicated on the side of the Master Module and can be accessed via the Display Module (***DISPLAY > STATUS > ACCURACY CLASS***).

Table 3.2 Metering Accuracy Class

Model	Class 1	Class 0.5	Class 0.2
M4	Standard	Not Available	Not Available
M5		Standard	Optional
M6		Standard	Optional
M8		Standard	Optional

Expressing Metered Data on the Display Module

The Display Module displays scaled metered data in its basic units, such as volts, amps, watts, etc. Prefixes such as “K” or “M” are used to denote multipliers of 1,000 (kilo-) and 1,000,000 (mega-). The DM expresses Power factor as a percentage, with a positive value indicating leading and a negative value indicating lagging.

The Display Module displays values to a maximum precision of five significant digits.

Viewing Metered Data Using the Display Module

The Display Module makes it easy to view the metering data produced by the Powermonitor 3000. Refer to Display Module Functionality later in this chapter for information on use of the Display Module.

Voltage, Current and Frequency Results

Line-to-line voltage results (*L1-L2, L2-L3,* and *L3-L1*) are calculated for all wiring modes. Line-to-neutral voltage results (*L1-N, L2-N,* and *L3-N*) are calculated in wye and single-phase wiring modes only. In delta wiring modes, line-to-neutral voltages return a zero value.

Average line-to-line (*Avg. L-L*) and line-to-neutral (*Avg. L-N*) voltage results return the mathematical average of the three line-to-line or line-to-neutral voltages, respectively. For single-phase wiring modes, the average line-to-neutral voltage is the mathematical average of phase 1 to neutral (*L1-N*) and phase 2 to neutral (*L2-N*) voltages. Voltage results return 999 if the line-to-neutral voltage exceeds 347 volts.

Current results include individual phase current (*L1, L2, L3*) and average 3-phase current. *L4* current returns neutral or zero-sequence current (refer to symmetrical component analysis discussion below).

Frequency results include *Last cycle frequency* and *Average Frequency*, calculated over your selection of either one or the last eight cycles. Frequency results return 0 if either the frequency is less than 40 Hz or if the voltage magnitude on all 3 voltage inputs is too low. Frequency results return 999 if the frequency is greater than 75 Hz. The Powermonitor 3000 selects one voltage phase input for frequency calculations and automatically switches to another in case of a phase loss. *Frequency source* indicates which phase is used to calculate frequency results.

Frequency source is accessible only via communications.

Phase rotation returns a value indicating forward (ABC), reverse (ACB) or no rotation.

RMS Resolution and Averaging

There are a number of configuration options in the Powermonitor 3000 that affect metering results.

- *RMS Resolution* – the high-resolution setting provides more accurate RMS results when significant levels of harmonics are present. You may also configure for nominal resolution if you require faster update rates but can accept lower accuracy as a trade-off. The M4 default is Nominal. The M5/M6/M8 default is High.
- *RMS Result Averaging* – the default setting provides a more steady result by averaging the results of the last 8 calculations. You may also configure “no averaging” for the fastest response to a changing signal.

- *Frequency Averaging* – like the RMS result averaging, the default setting provides for a smoother response by averaging the frequency of each of the last 8 cycles. You may select "no averaging" to return the frequency of only the last cycle

Refer to Advanced Device Configuration on page 3-23 for more information.

Symmetrical Component Analysis Results

The Powermonitor 3000 calculates sequence voltages and currents for use in symmetrical component analysis, a method of mathematically transforming a set of unbalanced three-phase vectors into three sets of balanced vectors. The positive sequence components are a set of vectors that rotate the same direction as the original power vectors, and represent that portion of the applied voltage or current capable of doing work. Negative sequence components rotate opposite to the original vectors, and represent the portion of the applied power that results in losses due to unbalance. The percent Unbalance value is the ratio between the negative and positive current sequence in a 3-phase system and is the most accurate measurement of current unbalance because it takes into account the magnitude of the individual currents and the relative phase displacement. The zero sequence component is a single vector that does not rotate, and represents ground or neutral current or voltage. The component analysis results returned include:

- Positive Sequence Current
- Negative Sequence Current
- % Current Unbalance
- Positive Sequence Voltage
- Negative Sequence Voltage
- % Voltage Unbalance
- *L4 current*, which is the zero-sequence current on a wye system when neutral current is connected to the I4 current input or in delta systems when an external zero sequence transformer is connected to the I4 input

Table 3.3 summarizes the voltage and current metering information provided by the Powermonitor 3000.

Table 3.3 Voltage, Current and Frequency Metering

Parameter	Description	Range	Units
Phase 1 L-N Voltage	RMS line to neutral voltage of individual phase or 3-phase average	0 to $999.9x10^{22}$	Volts
Phase 2 L-N Voltage			
Phase 3 L-N Voltage			
3-Phase Average L-N Voltage			
Phase 1 L-L Voltage	RMS line to line voltage of individual phase or 3-phase average	0 to $999.9x10^{22}$	Volts
Phase 2 L-L Voltage			
Phase 3 L-L Voltage			
3-Phase L-L Voltage			
Phase 1 Current	RMS line current in individual phase or 3-phase average	0 to $999.9x10^{22}$	Amps
Phase 2 Current			
Phase 3 Current			
3-Phase Average Current			
Phase 4 (Neutral) Current	RMS current of phase 4, also known as neutral or zero-sequence current.	0 to $999.9x10^{22}$	Amps
Frequency	The frequency of the voltage.	40.0 to 75.0	Hertz
Phase Rotation	The phase rotation of a 3-phase system	None ABC ACB	N/A
Voltage Positive Sequence	Magnitude of positive sequence voltage in a 3-phase system.(1)	0 to $999.9x10^{22}$	Volts
Voltage Negative Sequence	Magnitude of negative sequence voltage in a 3-phase system.(1)	0 to $999.9x10^{22}$	Volts
Current Positive Sequence	Magnitude of positive sequence current in a 3-phase system.	0 to $999.9x10^{22}$	Amps
Current Negative Sequence	Magnitude of negative sequence current in a 3-phase system.	0 to $999.9x10^{22}$	Amps
Voltage Unbalance	The ratio between the negative and positive voltage sequence in a 3-phase system.	0 to 100	Percent
Current Unbalance	The ratio between the negative and positive current sequence in a 3-phase system.	0 to 100	Percent

(1) Expressed in line-to-neutral volts for Wye and line-to-line volts for Delta wiring modes.

Power Results

Real power, that is the portion of the voltage and current applied to a power system that is doing work, is calculated on a per-phase (*L1 Real Power, L2 Real Power, L3 Real Power*), and *Total Real Power*. *L1 Reactive Power, L2 Reactive Power, L3 Reactive Power* and *Total Reactive Power* similarly return that portion of the power used in capacitive or inductive reactance in the power system and doing no work. *L1 Apparent Power, L2 Apparent Power, L3 Apparent Power* and *Total Apparent Power* return the apparent power, which is the simple mathematical product of the system voltage and system current.

For single-phase wiring mode, all *L3* power values remain at zero and are not included in the total power calculation.

Power Factor Results

The Powermonitor 3000 calculates true, displacement and distortion power factor, each on a per-phase and total 3-phase basis. *True power factor* is the ratio between the total true power and total apparent power (in percent), and takes into account the effect of phase shift between the voltage and current as well as any harmonics present. *Displacement power factor* is the cosine of the difference between the phase angle of the fundamental voltage and current (in percent), and reflects the value a typical analog power factor meter would measure. The true power factor and displacement power factor are equal only if there are no harmonics present in either the voltage or current. These values are signed to show lead (+) or lag (-). *Distortion power factor* is the ratio between the magnitude of the fundamental and the sum of the magnitudes for all of the current harmonics (in percent).

The power quantities (kW, kWh, kVAR, kVARh, and power factor) are four-quadrant measurements. The Powermonitor 3000 measures and expresses these measurements in a way that allows you to determine the magnitude and direction of both the real power flow and the reactive power flow. Figure 3.1 indicates the relationship between these quantities and the numeric signs used by the Powermonitor 3000 to convey the information.

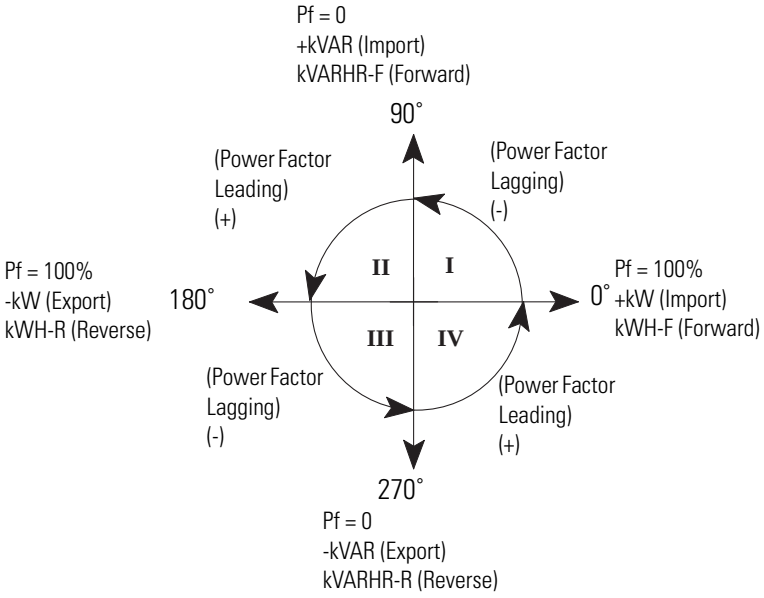
Table 3.4 Power and Power Factor Results

Parameter	Description	Range	Units
Phase 1 Power	Power of individual phase or sum of phases; signed to show direction.	0 to 999.9×10^{22}	Watts
Phase 2 Power			
Phase 3 Power			
3-Phase Total Power			
Phase 1 Reactive Power	Reactive power of individual phase or sum of all phases; signed to show direction.	0 to 999.9×10^{22}	VARs (volt-amperes reactive)
Phase 2 Reactive Power			
Phase 3 Reactive Power			
3-Phase Total Reactive Power			
Phase 1 Apparent Power	Apparent power of individual phase or sum of all phases.	0 to 999.9×10^{22}	VA (volt-amperes)
Phase 2 Apparent Power			
Phase 3 Apparent Power			
3-Phase Total Apparent Power			
Phase 1 True Power Factor	The ratio between the power and apparent power for an individual phase or all three phases; signed to show lead (+) or lag (-).	-100 to 100	Percent
Phase 2 True Power Factor			
Phase 3 True Power Factor			
Total True Power Factor			

Table 3.4 Power and Power Factor Results

Parameter	Description	Range	Units
Phase 1 Distortion Power Factor	The ratio between the magnitude of the fundamental and the sum of the magnitudes for all of the current harmonics for an individual phase or all three phases.	0 to 100	Percent
Phase 2 Distortion Power Factor			
Phase 3 Distortion Power Factor			
Total Distortion Power Factor			
Phase 1 Displacement Power Factor	The cosine of the phase angle between the fundamental voltage and current for an individual phase or all three phases; signed to show lead (+) or lag (-).	-100 to 100	Percent
Phase 2 Displacement Power Factor			
Phase 3 Displacement Power Factor			
Total Displacement Power Factor			

Figure 3.1 Explanation of Power Factor Values



Energy Results

The Powermonitor 3000 calculates energy values including kWh forward, reverse and net; kVAh; kVARh forward, reverse and net; and kAh. You may read these values using the Display Module or via communications.

Configurable Energy Counter Rollover

You may configure the number of digits at which energy values roll over to zero. The parameter range is 4 to 15 digits. Configure this setting in Advanced Device Configuration using the Display Module or by writing to Table A.6. This setting allows you to optimize the energy counter rollover for use with applications that support a limited number of significant digits. For instance, the Display Module supports a resolution of five significant digits. The Trend Log, which is used for automatic data re-population in some energy logging applications such as RSEnergyMetrix, supports twelve significant digits with eight digits of precision.

Demand Calculation

A typical industrial utility bill includes not only an energy (or kWh) charge but also a *Demand* charge. Demand is equal to the average power level during a predefined time interval. Some power providers may base demand on current, VA, or VARs instead of kW. This interval continuously repeats and is typically between five and 30 minutes in length. The formula for kW demand is shown below:

$$\text{Demand} = \frac{1}{T} \bullet \int_{t}^{t+T} P(t)\,dt$$

T = Demand interval duration
t = Time at beginning of interval
P(t) = Power as a function of time

Usually, a utility rate tariff includes a peak demand charge, determined by the peak demand that occurs during a specified period, which may be one month, one year, or some other duration. As a result, only one occurrence of a high demand level can have a long-term effect on your utility bill. The peak demand value indicates to the utility the reserve capacity they need to satisfy your short-term power requirements. The peak demand charge helps to pay the utility for maintaining this instantaneous capacity.

The Powermonitor 3000 computes demand levels for watts, VA, amps, and VARs, and provides three different methods for projecting demand.

The utility may provide a pulse that indicates the end of each demand interval. The utility updates the demand value at the end of each interval and maintains the highest value obtained during any interval.

This method is known as *thermal demand*. You may set up a Powermonitor 3000 to determine its demand interval from the utility pulse. To accomplish this, connect the utility pulse to status input #2 and make the appropriate settings in the *Advanced Device Configuration*.

If the utility does not provide a demand interval pulse, you won't be able to synchronize with the utility to control your demand. In this case, you may use the *sliding window* method. This method breaks the demand interval into many sub-intervals and updates the demand value at the end of each sub-interval. For example a five-minute interval might be divided into five one-minute sub-intervals. The demand for each one-minute interval is calculated and at the end of five minutes the average value of the sub-intervals is computed to obtain a demand value. At the end of the sixth minute, the value for sub-interval one is discarded and a new demand value computed based on sub-intervals two through six. In this way a new five-minute demand value is obtained every minute. The maximum value is then maintained as the peak demand. This method approximates the actual demand the utility measures.

How can you minimize your peak demand in order to reduce your utility demand penalty charges? One way is to measure the power being used and project the demand level at the end of the interval. This method permits you to reduce power consumption when the projected demand reaches a predetermined threshold, thus preventing the final demand from exceeding the desired level.

Projected Demand Calculation

Select the best projection method for your system by comparing the projected values from each method with the actual demand at the end of the interval. The three methods of projecting demand are described below.

Instantaneous

The Powermonitor 3000 computes instantaneous demand by substituting the elapsed interval duration for the total interval duration (T) in the demand equation. It is therefore identical to the standard computation except it integrates the power only over the elapsed interval duration and calculates the average value over the elapsed duration. The modified equation thus becomes:

$$\text{Demand} = \frac{1}{t2 - t1} \bullet \int_{t1}^{t2} P(t)dt$$

(t2 - t1) = Elapsed interval duration and is less than T

First Order Projection

The first order demand projection utilizes the instantaneous demand as a starting point, computes the trend of the instantaneous demand, computes the time remaining in the interval, and performs a first order projection of what the final demand will be at the end of the interval. This method may be useful where your system has a significant base load with additional loads that are switched in and out during the interval.

Second Order Projection

The second order demand projection begins with the first order projection. It computes the rate of change of the first order trend, computes the time remaining in the interval, and performs a second order projection of what the final demand will be at the end of the interval. This method may be useful where your power system has little or no base load and a load profile that increases over the duration of the interval. A second order projection is more sensitive to rapid load changes than the other methods.

Table 3.5 Energy and Demand Results

Parameter	Description	Range	Units
Kilo-Watt Hours Forward	The total real power consumed	0 to $1.0x10^{12}$	kWh
Kilo-Watt Hours Reverse	The total real power produced		
Kilo-Watt Hours Net	The sum of forward and reverse power		
Kilo-VAR Hours Forward	The total reactive power consumed	0 to $1.0x10^{12}$	kVARh
Kilo-VAR Hours Reverse	The total reactive power produced		
Kilo-VAR Hours Net	The sum of forward and reverse reactive power		
Kilo-VA Hours Net	The total apparent power consumed	0 to $1.0x10^{12}$	kVAh
Amp Hours Net	Accumulated amp-hours consumed.	0 to $1.0x10^{12}$	Ah
Demand Current	The calculated demand for average current.	0 to $999.9x10^{21}$	Amps
Max Demand Current	The maximum (peak) demand for current. (included in Min/Max Log)		
Demand Kilo-Watts	The calculated demand for real power.	0 to $999.9x10^{21}$	kW
Max Demand Kilo-Watts	The maximum (peak) demand for real power (included in Min/Max Log)		

Table 3.5 Energy and Demand Results

Parameter	Description	Range	Units
Demand Kilo-VARs	The calculated demand for reactive power.	0 to $999.9x10^{21}$	kVAR
Max Demand Kilo-VARs	The maximum (peak) demand for reactive power (included in Min/Max Log)		
Demand Kilo-VA	The calculated demand for apparent power.	0 to $999.9x10^{21}$	kVA
Max Demand Kilo-VA	The maximum (peak) demand for apparent power (included in Min/Max Log)		
Projected Current Demand(1)	The projected demand for average current	0 to $999.9x10^{21}$	Amps
Projected Kilo-Watt Demand(1)	The projected demand for real power	0 to $999.9x10^{21}$	kWatts
Projected Kilo-VAR Demand(1)	The projected demand for reactive power	0 to $999.9x10^{21}$	kVARs
Projected Kilo-VA Demand(1)	The projected demand for apparent power	0 to $999.9x10^{21}$	kVA

(1) Values returned depend on user selection of projected demand type in Advanced Configuration.

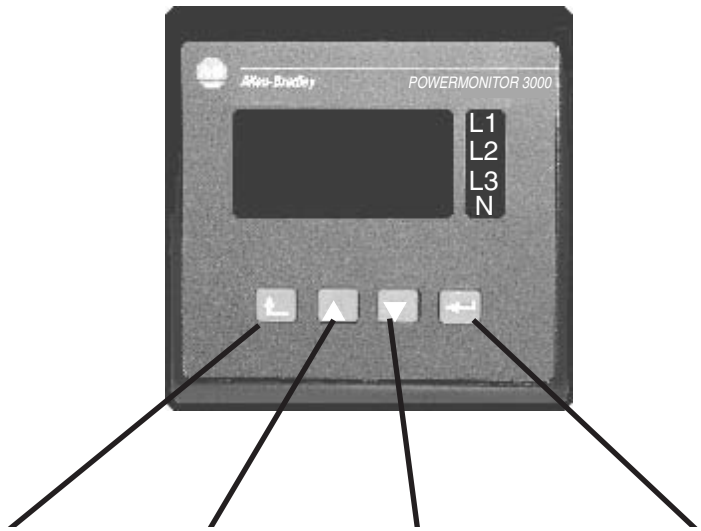
Display Module Functionality

The Display Module is a simple terminal that allows you to easily view metering parameters or change configuration items. The Display Module uses three modes of operation.

- *Display mode* allows you to view Powermonitor 3000 parameters including metering, setpoint, min/max log, event log and self-test information. You may also select a default screen to be displayed at power-up or after 30 minutes without key activity.
- *Program mode* allows you to change configuration parameters, with security against unauthorized configuration changes. Each Powermonitor 3000 is password protected. In Program Mode, the Display Module phase indicators (L1,L2,L3,N) flash.
- *Edit mode* allows you to modify the selected parameters. In Edit mode, the parameter being modified flashes, and the phase indicators (L1,L2,L3,N) remain solid.

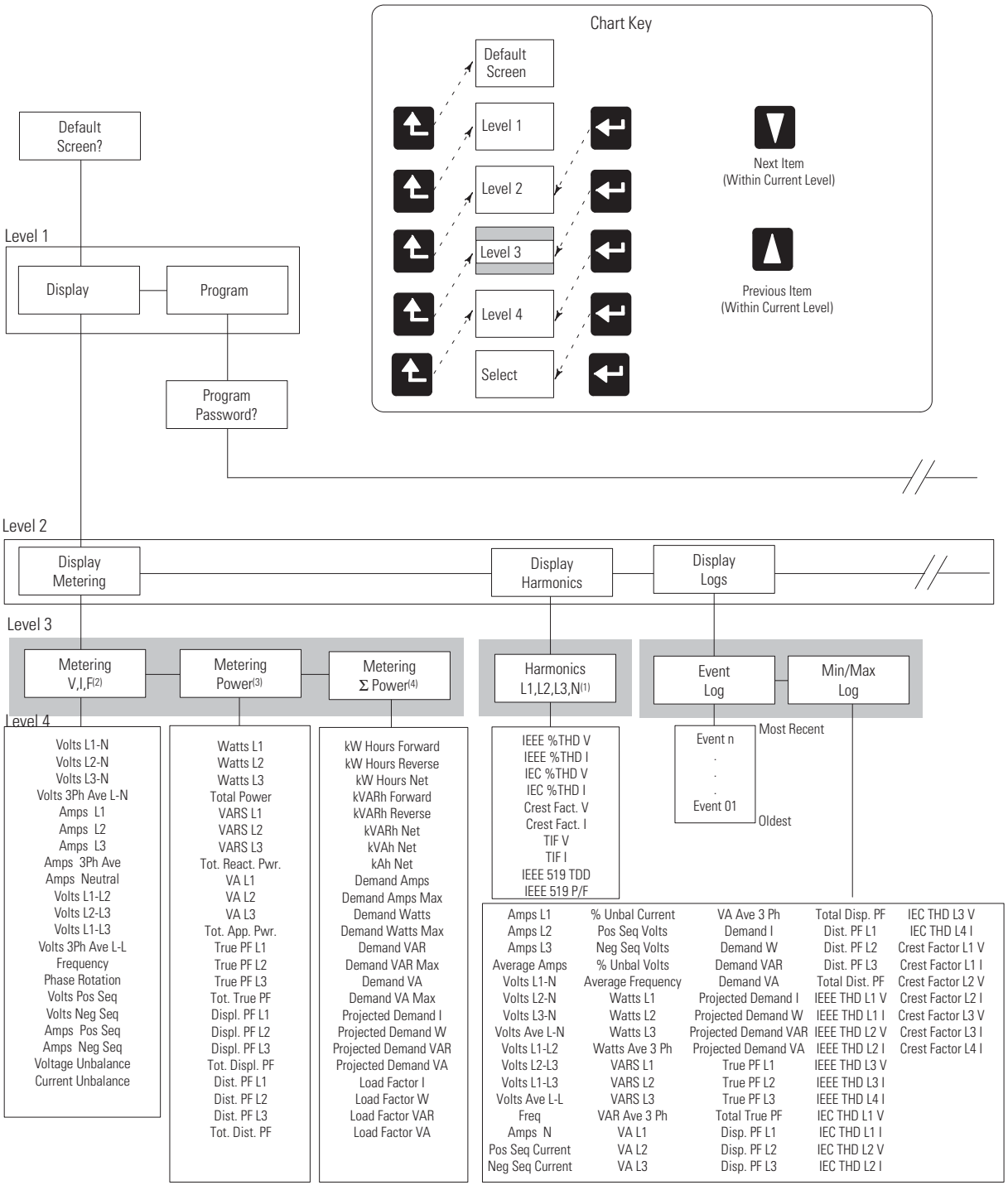
Key Functions

The Display Module has four keys located on its front bezel: an *Escape* key, *Up Arrow* key, *Down Arrow* key, and an *Enter* key. These keys differ slightly in how they function in each mode. See Figure 3.2 for a description of their functionality.



	Escape Key	Up Arrow Key	Down Arrow Key	Enter Key
Display Mode	Returns to parent menu	Steps back to the previous parameter/menu in the list	Steps forward to the next parameter/menu in the list	Steps into a sub-menu or sets as default screen
Program Mode	Returns to parent menu	Steps back to the previous parameter/menu in the list	Steps forward to the next parameter/menu in the list	Steps into a sub-menu, selects the parameter to be modified or changes to Edit mode
Edit Mode	Cancels changes to the parameter, restores the existing value, and returns to Program mode	Increments the parameter/menu value	Decrements the parameter value	Saves the parameter change to the Master Module and returns to Program mode

Figure 3.2 Menu/Parameter Structure



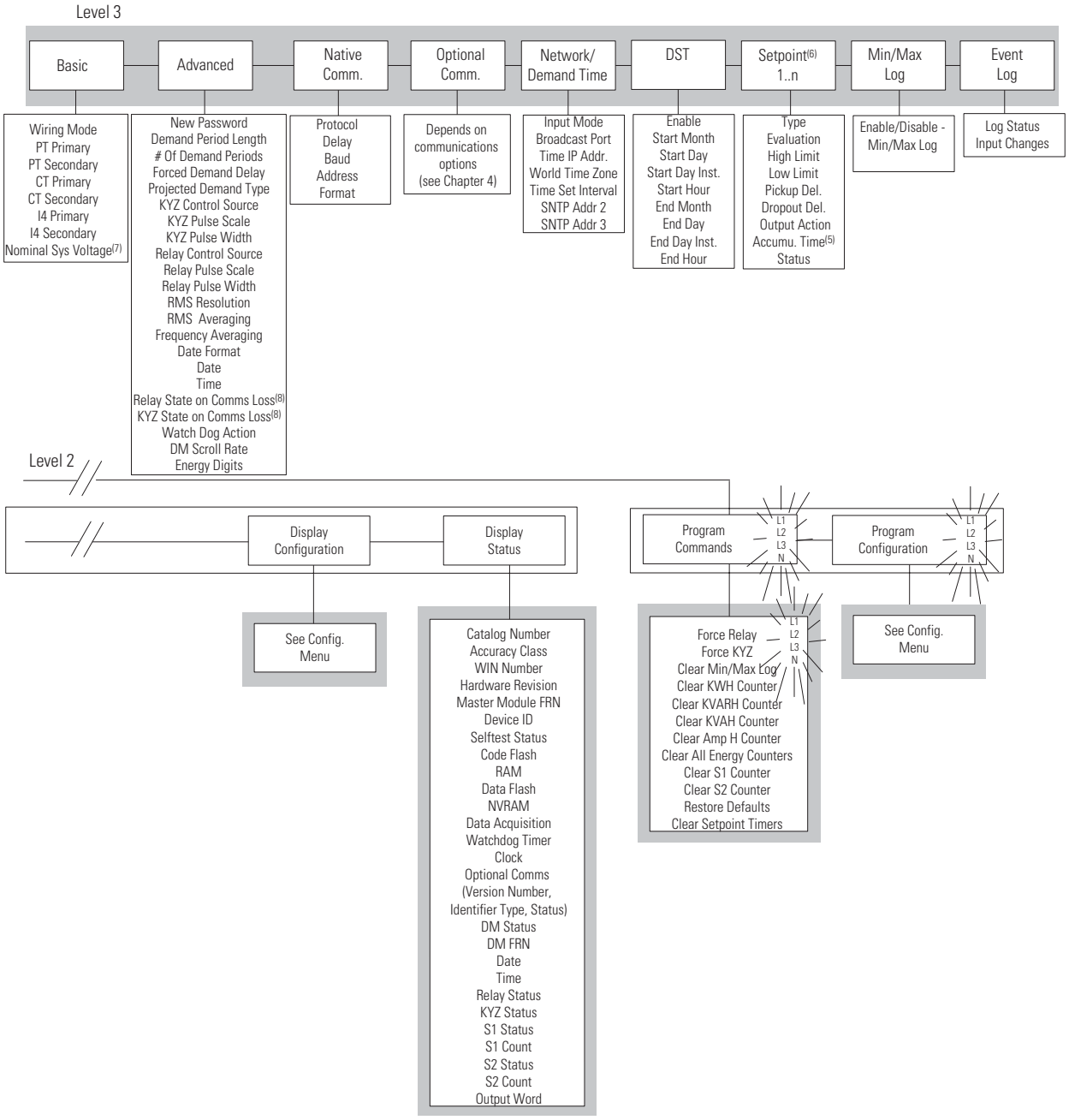
(1) Voltage THD and Crest Factor Voltage are omitted for neutral channel.

(2) Parameters displayed depend on the wiring mode.

(3) Individual phase parameters are omitted in delta wiring modes.

(4) Load factor parameters are available only on M6 and M8 modules.

Configuration Menu



(5) In Program Mode, this entry becomes Clear Accumulated Time.

(6) 1..10 (M4, M5) or 1..20 (M6, M8).

(7) Available on M6 and M8 only.

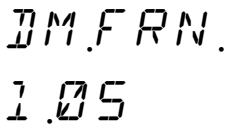
(8) Applies to EtherNet/IP Series B, ControlNet, DeviceNet and Remote I/O only.

Displaying Information

The display screen consists of two rows of five alpha-numeric LED digits. At the right of this screen is a column of phase indicators: L1, L2, L3 and N. These indicators show which phase (or phases) is referred to by the information being displayed on the 2x5 screen. The phase indicators also indicate program mode by flashing.

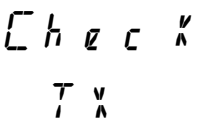
Power Up

When the DM powers up, it first illuminates all of its LED's for approximately 2 seconds. It then displays its firmware revision number:



After about 2 seconds, the display waits for communication with the Master Module. If it doesn't receive any messages within 8 seconds, it displays:

At any time, if the DM stops receiving information from the Master Module, it displays the Check Rx message. If it is receiving messages but not able to send messages (it determines this from a lack of response from the Master Module), the DM displays:



Once the DM begins communicating with the Master Module, it displays it on the screen and the Check Rx or Check Tx messages disappear. No operator intervention is required to clear these messages.

Scrolling

When messages are too large to fit on the display, a scrolling mechanism is employed. The message scrolls horizontally. The default scroll rate was chosen to give you enough time to see the message but not take too much time to show the entire message. You may select from two different scroll rates using the Advanced Configuration Menu on the Display Module. Take care to see the entire message before taking any action as some of the messages are very similar and differ only by a few characters.

Editing a Parameter

1. Using the Display Module keys, move into Program mode and display the parameter to be modified. Notice the flashing phase indicators on the right-hand side of the screen.

Figure 3.3 Edit Mode

2. Set the Display Module into Edit mode by pressing the *Enter* key. Notice that the phase indicators on the right side turn-on solid and the parameter being modified is now flashing.

Figure 3.4 Parameter Change

3. Change the value of the parameter by pressing the *Up Arrow* and *Down Arrow* keys until the desired parameter value is displayed. Notice the phase indicators on the right-hand side remain solid and the parameter being modified is still flashing.

4. After the desired parameter value is displayed, press the *Enter* key to write the new value to the Master Module and set the Display Module back to Program mode. Notice the phase indicators on the right-hand side are now flashing and the parameter being modified is now solid.

5. If you begin to edit the wrong parameter, press the *Escape* key. This returns the original parameter value, does not modify the Master Module, and returns the Display Module to Program mode. Notice the phase indicators on the right-hand side are flashing again, and the parameter being modified is now solid.

Setting a Default Screen

To set the current Display Module view as the default screen, press the *Enter* key. The display will read "Set Default" with "No" flashing in the second line. Press the *Down Arrow* key to change "No" to "Yes." Press the Enter key again to confirm your selection.

The Display Module will now return to the screen you have selected on power up or after 30 minutes of inactivity on the Display Module.

Issuing Commands

The Display Module allows you to issue commands to the Powermonitor 3000. These commands include relay and KYZ output forcing; clearing the Min/Max Log; clearing energy and amp-hour counters, status input counters and setpoint counters, and restoring the factory defaults.

To issue a command, you must enter *Program Mode* and enter the correct unit *Password*.

ATTENTION

The relay and KYZ outputs may be connected to field devices. Before issuing a command to force an output, ensure that any devices connected to outputs cannot operate in an unsafe or undesired manner. Failure to follow these instructions may result in personal injury or death, property damage or economic loss.

1. Using the four Display Module keys, move into Program mode and display the command to be issued. Notice the flashing phase indicators on the right-hand side.

Figure 3.5 Program Mode

2. Set the Display Module into Edit mode by pressing the *Enter* key. Notice that the phase indicators on the right-hand side are now solid and the command option prompt is now flashing.

Figure 3.6 Edit Mode

3. Choose the option of the command by pressing the *Up Arrow* and *Down Arrow* keys until the desired option is displayed. Notice the phase indicators on the right-hand side remain solid and the command option being selected is still flashing.

Figure 3.7 Command Option

4. After the desired command option is displayed, press the Enter key to execute the command. The selection prompt reappears and the Display Module is set back to Program mode. Notice the phase indicators on the right-hand side are flashing again and the option prompt is now solid.

Figure 3.8 Program Mode

5. To abort a command, press the *Escape* key. The Display Module returns to Program mode and the option prompt is displayed again. Notice the phase indicators on the right-hand side are now flashing and the option prompt is now solid.

Table 3.6 Commands

Parameter	Description	Range
Force Relay	Forces relay to a known state in which the relay remains at that state until the force is removed.	De-energize Energize No Force
Force KYZ	Forces KYZ to a known state in which the relay remains at that state until the force is removed.	De-energize Energize No Force
Clear Min/Max Log	Resets the Min/Max log with the current real time metering information.	Yes No
Clear kWh Counter	Resets the kWh net counter to zero.	Yes No
Clear kVARh Counter	Resets the kVARh net counter to zero.	Yes No
Clear kVAh Counter	Resets the kVAh net counter to zero.	Yes No
Clear Ah Counter	Resets the Ah net counter to zero.	Yes No
Clear All Energy Counters	Resets all cumulative energy counter to zero.	Yes No
Clear S1 Counter	Resets Status 1 counter to zero.	Yes No
Clear S2 Counter	Resets Status 2 counter to zero.	Yes No
Restore Defaults Settings	Restores all settings to factory default.	Yes No
Clear Setpoint Timers	Clears the time accumulated in each setpoint timer.	Yes No

Configuration Using the Display Module

The Display Module provides an inexpensive, easy-to-operate method for setting up Powermonitor 3000 parameters to adapt it to your power system and select the performance options you desire. You configure the Powermonitor 3000 using Program Mode and Edit Mode of the Display Module. Once you have become familiar with the key functions, you will find that setting up a new Powermonitor 3000 is a simple process.

You may also configure the Powermonitor 3000 via communications, and certain advanced features of the Powermonitor 3000 may be configured only via communications. Please refer to the appropriate sections of the User manual for more information.

Refer to Table 3.7 for a summary of basic and advanced device configuration settings. You may use a copy of this table to record your configuration settings.

Basic Device Configuration

The basic unit configuration sets the wiring mode, PT ratios and CT ratios to match your power system. Every Powermonitor 3000 requires basic configuration. To perform basic configuration using the Display Module, navigate through these menus: ***PROG.*** > ***PASS?*** > ***CONFIGURATION*** > ***BASIC***. You may also set the basic device configuration via communications by writing to Table A.4.

Wiring Mode

Select the wiring mode to match the physical configuration of your power system. Your wiring mode choice must match the wiring diagrams found in the Installation Manual for proper operation and accuracy. Your choices are:

- Delta 3 CT
- Delta 2 CT
- Direct Delta 3 CT
- Direct Delta 2 CT
- Open Delta 3 CT
- Open Delta 2 CT
- Wye (default)
- Single Phase
- Demo

You may choose *Demo mode* for training or demonstration purposes. In demo mode, the Powermonitor 3000 returns internally generated results.

PT and CT Ratios

You may directly connect the voltage inputs of the Powermonitor 3000 to power systems rated at 600 volts line-to-line or less. Above 600 volts, you will need potential transformers (PTs) to step down the power system voltage to one that is measurable. Most commercially available PTs have a secondary rated voltage of 120 volts (150 volts full-scale).

Nearly every Powermonitor 3000 installation will require CTs to step down the power system current to a value of 5 amps full-scale.

To perform basic configuration, set the primary and secondary voltage and current ratings of your PTs (if used) and CTs. If your system configuration includes a neutral current CT, you will need to separately configure the I4 CT ratio.

- *PT primary:* range 1 to 10,000,000, default 480
- *PT secondary:* range 1 to 600, default 480
- *CT primary:* range 1 to 10,000,000, default 5
- *CT Secondary:* range 1 to 5, default 5
- *I4 primary and I4 secondary:* same as CT primary and secondary

For direct connection to power systems of 600 V, set the PT ratio to 600:600. For a 480 V system, set the PT ratio to 480:480.

Nominal system voltage (M6, M8 only)

The M6 and M8 models use the nominal voltage setting for calculating the default sag and swell setpoint high and low limits. For Wye and single-phase wiring modes, set this value to the PT primary-side nominal line-to-neutral. For all other wiring modes, set this parameter to the PT primary-side nominal line-to-line voltage. Range 1 to 10,000,000, default 480.

TIP When setting a parameter, you may press and hold the up arrow or down arrow key for a few seconds to increase the rate the value increments or decrements.

Refer to the Powermonitor 3000 Installation Instructions, publication 1404-IN007 for information on selecting and installing PTs and CTs.

Advanced Device Configuration

A number of parameters are grouped into Advanced Configuration, including the *Password*, demand and projected demand setup, relay and KYZ pulse operation setup, metering accuracy options, date/time and Display Module scrolling rate. To perform advanced configuration using the Display Module, navigate through these menus: ***PROG.*** > ***PASS?*** > ***CONFIGURATION*** > ***ADVANCED***. You may also set the advanced device configuration via communications by writing to Table A.6.

Password

The password protects the unit against unauthorized commands or configuration changes. Be sure to write down the new password and keep it in a safe place. Range 0 to 9999, default 0000.

TIP If you forget or lose your password, contact Rockwell Automation Technical Support for assistance. Refer to Rockwell Automation Support on the back cover of this manual.

Table 3.7 Device Configurations Summary

	Parameter	Range	Default	User Setting
Basic Configuration	Wiring Mode	0 = Delta 3 CT 1 = Delta 2 CT 2 = Direct Delta 3 CT 3 = Direct Delta 2 CT 4 = Open Delta 3 CT 5 = Open Delta 2 CT 6 = Wye 7 = Single Phase 8 = Demo	6 = Wye	
	PT Primary	1 to 10,000,000	480	
	PT Secondary	1 to 600	480	
	CT Primary	1 to 10,000,000	5	
	CT Secondary	1 to 5	5	
	I4 Primary	1 to 10,000,000	5	
	I4 Secondary	1 to 5	5	
	Nominal System Voltage (M6 and M8 only)	1 to 10,000,000	480	

Table 3.7 Device Configurations Summary

	Parameter	Range	Default	User Setting
Advanced Configuration	New Password	-1 to 9999	0000	
	Demand Period Length	-99 to 99	15	
	Number of Demand Periods	1 to 15	1	
	Forced Demand Delay(1)	0 to 900 Seconds	10	
	Predicted Demand Type	Instantaneous 1st Order 2nd Order	Instantaneous	
	KYZ Control Source	0 = None 1 = Wh Forward 2 = Wh Reverse 3 = VARh Forward 4 = VARh Reverse 5 = Vah 6 = Ah 7 = Setpoint 8 = Comms	7 = Setpoint	
	KYZ Pulse Output Scale	1 to 30000	10	
	KYZ Pulse Output Width	0, 40 to 2000	0	
	Relay Control Source	Same as KYZ	7 = Setpoint	
	Relay Pulse Output Scale	1 to 30000	10	
	Relay Pulse Output Width	0, 40 to 2000	100	
	RMS Resolution	Nominal / High	High(3)	
	RMS Averaging	On / Off	On	
	Frequency Averaging	On / Off	On	
	Date Format	MM/DD/YYYY DD/MM/YYYY	MM/DD/YYYY	
	Date: Year	1998 to 2097	1998	
	Date: Month	1 to 12	1	
	Date: Day	1 to 31	1	
	Time: Hour	0 to 23	0	
	Time: Minutes	0 to 59	0	
	Time: Seconds	0 to 59	0	
	Default relay state on comms loss	0 = Last state/resume 1 = Last state/freeze 2 = De-energize/resume 3 = De-energize/freeze	0	
	Default KYZ state on comms loss		0	
	Wdog action	0 = Halt 1 = Continue	0 = Halt	
	Display Module Scroll Speed	Fast / Slow	Fast	
	Energy counter rollover point	4 to 15 digits	15	
	Metering Result Set (M8 only(2))	0 = All results 1 = Transducer mode 2 = Energy meter mode	0 = All results	

(1) Available with Master Module firmware V2.34 or greater

(2) Metering result set parameter may only be configured using communications.

(3) Factory default for RMS Resolution is Nominal for the M4 and High for the M5, M6 and M8.

Demand Setup

You may configure the demand period length, the number of demand periods to average for demand calculation, the forced demand delay and the type of calculation used for projected demand.

Demand Period Length sets the length in minutes (1 to 99) of the demand period used for demand and projected demand calculation. Range –99 to +99, default 15.

- A positive value (other than 0) configures the Powermonitor 3000 to use its internal clock to measure the demand period.
- A setting of zero (0) configures the Powermonitor 3000 to use the utility pulse connected to status input #2 to synchronize the demand interval
- A negative value configures the Powermonitor 3000 to use its internal clock for calculating projected demand and the utility pulse to calculate actual demand

Number of Demand Periods specifies how many demand intervals are averaged together to a floating window demand calculation. For instance, to configure a 30 minute floating window, specify “2” as the demand period length and “15” as the number of demand periods. Range 1 to 15, default 1.

Forced Demand Delay is a timeout setting that waits for “x” number of seconds before ending a demand period when the external demand sync input function is being used. When a missed external demand sync is detected,

- The unit forces an end to the current demand period.
- Records an event log record of the event.
- Records a trend log record if the trend log interval is set to -1. (Sync with demand setting)
- Sends out a demand sync broadcast when configured as a “Master” and the unit is a series “B” with an Ethernet communication card option.
- Starts the projected demand calculations from the beginning again.

Entering a value of “0” will disable this function. For more information about this feature read the section Network Demand / Time Configuration, page 3-29.

Projected Demand Type specifies the type of calculation used for projected demand. Selections are:

- Instantaneous (default)
- First-order
- Second order.

Relay and KYZ Pulse Operation Setup

Use these configuration parameters to select how the relay and KYZ solid-state outputs are controlled. *Relay control source* controls the selection which includes:

- Disabled
- Wh forward
- Wh reverse
- VARh forward
- VARh reverse
- Vah
- Ah
- Setpoints (default)
- Remote I/O or DeviceNet discrete control

The *Pulse output scale factor* sets the number of measurement increments per pulse. Range 1 to 30,000, default 10. The *Pulse output width* parameter determines the pulse width in milliseconds. Range 40 to 2,000 or 0 to transition the output KYZ-style. Default is 0.

Metering options

Configuration parameters *RMS Result Averaging, RMS Resolution* and *Frequency Averaging* allow you to make choices to fit the Powermonitor 3000 more closely to your application needs. The default settings are to average 8 RMS and frequency calculations, providing a smoother result, and to sample at a high rate, providing greater accuracy where significant harmonics are present. Refer to the discussion of these parameters in *Metering Functionality* at the beginning of this chapter.

Configurable Energy Counter Rollover

You may configure the number of digits (range 4 to 15) at which energy values roll over to zero. Configure this setting using the Display Module or by writing to Table A.6.

Advanced Metering Options

Some applications require very frequent updates of a limited set of metering data. In the M8 model, you may de-select certain metering functions to improve the update rate of the Powermonitor 3000 in its remaining metering and communications functions. With this feature selected, de-selected metering calculations return values of 0 in the appropriate data table elements.

You may set the advanced metering selection only through communications, by performing a table write to Table 46: Advanced metering configuration. The Display Module does not support this configuration. This table exists only in the M8 model and consists of 10 integer elements as follows:

- *Password:* A valid password is required
- *Meter result set:* 0 calculates all metering results (default); 1 is transducer mode; 2 is energy meter mode
- *Reserved elements:* The remaining elements must be 0

Transducer mode: The Powermonitor 3000 calculates only volts, amperes, watts, VARs, VA, true power factor (per phase and total) and frequency.

Energy meter mode: The unit calculates only average voltage, average amperes, total watts, frequency and net kWh.

Date and Time

You may use these parameters to set the Powermonitor 3000's internal clock and calendar and configure the display format as MM/DD/YYYY (default) or DD/MM/YYYY. The Powermonitor 3000 uses its internal clock time-stamp entries in logs, oscillograms and transient captures.

Display Mode Scroll Speed

This parameter controls how fast text that doesn't fit in the window is scrolled on the Display Module. Default is fast scrolling.

Watchdog Timeout Action

Configure this parameter to determine how the Powermonitor 3000 responds if an internal watchdog timeout has occurred. This may occur due to extreme environmental condition or internal operational error. Choices are:

- Halt - Restart the firmware, log an event, stop metering and disable all functionality except Display Module and communications.
- Continue - Restart the firmware, log an event and resume operation.

Default is Halt. This parameter is available in only in firmware versions 2.xx and greater.

Default Output Behavior on Communications Loss

Refer to Communications Loss Behavior on page 6-4.

Network Demand / Time Configuration

The Ethernet Series B Powermonitor 3000 supports demand period synchronization via the Ethernet network. Demand period synchronization makes use of UDP (User Datagram Protocol) messaging, a simplified, low-level protocol that supports broadcasts. A Powermonitor 3000 may be configured as a "Master" or a "Slave". A Master may be configured to receive an end-of-interval (EOI) signal either from a dry contact connected to its Status Input 2 or via a Controller Command write to Table A.53 (see below). When a Master receives an EOI input, it broadcasts an EOI message to any units configured as "Slaves".

Series B Ethernet units also support synchronization of their internal clocks from an SNTP server (or up to three SNTP servers in MM FRN 2.5x or later), at a configurable synchronization interval. Since SNTP servers operate in UTC (Universal Coordinated Time), a time zone for the Powermonitor 3000 must also be configured for the correct time to be set. The time zone is configured as an offset in hours from UTC (formerly known as GMT).

You may configure network demand and time synchronization options using the display module. This function is only supported on Ethernet Series B Powermonitor 3000 units. The configuration menu does not appear on other Powermonitor 3000 units. To set the configuration options described below using the display module, navigate through these menus: ***PROG. > PASS? > CONFIGURATION > NETWORK DEMAND/TIME***.

You may also configure network demand and time synchronization using communications, by writing to Table A.52

Input mode

Sets the unit network time sync mode. Range: 0 = Master command input, 1 = Master status 2 input, 2 = Slave broadcast input, 3 = Slave status 2 input (default)

Broadcast port

Sets the UDP port number for the master slave configuration. Range 300 to 400, default 300

Time IP address

The IP address of the primary SNTP server, accessed as the 1st through 4th octet

World time zone

Sets the time zone of the Powermonitor 3000. Range: -12 = GMT - 12:00 - Eniwetok, Kwajalein; -11 = GMT - 11:00 - Midway Island, Samoa; ...; 12 = GMT - 12:00; Fiji, Kamchatka, Marshall Island.

Time-set interval

Determines how often the unit time is automatically set, in seconds. Range: 0 to 32,766. 0 = Disables the time set function, Default = 60

SNTP address 2

The IP address of the primary SNTP server, accessed as the 1st through 4th octet. Available only in master module firmware version 2.5x and later

SNTP address 3

The IP address of a third SNTP server, accessed as the 1st through 4th octet. Available only in master module firmware version 2.5x and later

Table 3.8 Network demand/time configuration summary

Parameter name	Range	Default	User Setting
Input mode	0-3	3	
Broadcast port number	300 to 400	300	
Time server IP address-byte 1	0 to 255	0	
Time server IP address-byte 2	0 to 255	0	
Time server IP address-byte 3	0 to 255	0	
Time server IP address-byte 4	0 to 255	0	
Time zone	-12 to 12	0	
Time set update interval	0 to 32766	60	
SNTP IP address 2, octet 1	0-255	0	
SNTP IP address 2, octet 2	0-255	0	
SNTP IP address 2, octet 3	0-255	0	
SNTP IP address 2, octet 4	0-255	0	

Table 3.8 Network demand/time configuration summary

Parameter name	Range	Default	User Setting
SNTP IP address 3, octet 1	0-255	0	
SNTP IP address 3, octet 2	0-255	0	
SNTP IP address 3, octet 3	0-255	0	
SNTP IP address 3, octet 4	0-255	0	

Controller Command

Table A.53 is a write table consisting of one integer element. A "1" written to bit 0 signals the end of a demand period. When this occurs, the Master Powermonitor resets this bit to 0 and sends the end of demand broadcast to Powermonitor units configured as "Slave broadcast input". Bits 1 through 15 are reserved.

DST (Daylight savings time) configuration

The Powermonitor 3000 may be configured to automatically adjust its internal clock for daylight savings time. Daylight savings time functionality is available only in Powermonitor 3000 models with firmware revision 2.5x or later.

To set configuration options described below using the display module, navigate through these menus: ***PROG. > PASS? > CONFIGURATION > DST.***

You may also configure the daylight savings time function via communications by writing to the Daylight Savings Time Configuration Table A.54.

DST enable

Enables the daylight savings time function. Range 0 = disable, 1 = enable

DST start month

Selects the calendar month when daylight savings time begins. Range 1 = January, 2 = February, … , 12 = December

DST start day

Selects the day of the week when daylight savings time begins. Range 0 = Sunday, 1 = Monday, … , 7 = Saturday

DST start day instance

Selects which instance of the DST start day in the DST start month when DST begins. Range 1 = first, 2 = second, 3 = third, 4 = fourth, 5 = last

DST start hour

Selects the hour of the day when DST begins. Range 0 = midnight, 1 = 1:00 a.m., … , 23 = 11:00 p.m.

DST end month

This parameter and the following three determine when DST ends and are configured the same as the start parameters above.

- DST end day
- DST end day instance
- DST end hour

DST is disabled by default. When enabled, the default start time is 2:00 a.m. on the first Sunday in April, and the default end time is 2:00 a.m. on the last Sunday in October.

Table 3.9 Daylight savings time configuration summary

Parameter name	Range	Default	User Setting
DST Enable	0 to 1	0	
DST Start Month	1-12	4	
DST Start Day	0-6	0	
DST Start Day Instance	1-5	1	
DST Start Hour	0-23	2	
DST End Month	1-12	10	
DST End Day	0-6	0	
DST End Day Instance	1-5	5	
DST End Hour	0-23	2	

Metering Update Rate

The metering update rate is a measure of how often the PM3000 calculates new metering results. The metering update rate is not significant in most applications, but can be important in some control applications. The metering update rate affects how quickly a setpoint can respond to an electrical event and affects how often new metering results are available for communications. The metering update rate is dependent on the PM3000 model and device configuration.
Table 3.10 contains information that can be used to calculate the metering update rate for a specific model containing specific configuration selections.

Table 3.10 Metering update rate calculation based on model and device configuration

Model and config options	M4	M5	M6	M8	Update rate
Base metering update rate	•	•	•	•	45mS
If device is an M4	•				Add 10mS
If RMS Resolution = High (see Table A.6)	•	•	•	•	Add 10mS
If catalog # contains ENT, CNT, or DNT	•	•	•	•	Add 5mS
If the Min/Max log is enabled (see Table A.23)	•	•	•	•	Add 5mS
If more than 5 setpoints are configured	•	•	•	•	Add 5mS
If Oscillography is enabled (see Table A.39)			•	•	Add 5mS
If Transient detection is enabled (see Table A.43)				•	Add 15mS
If Meter Result Set is set to Tranducer mode or Emergy Meter Mode (see Table A.47)				•	Subtract 5mS

Table 3.11 lists the minimum and maximum possible metering update rate for each model based on information from Table 3.10.

Table 3.11 Min and max metering update rate for each model

Model	Min and Max metering update rate
M4	55-80mS
M5	45-70mS
M6	45-75mS
M8	40-90mS

Out-of-the-box metering update rates are based on factory-default configuration data and are listed in Table 3.12 for all PM3000 model and communication options. Factory default settings for configuration parameters can be found in Appendix A.

Table 3.12 Meter update rate with factory default configuration

Model	Communication option	
	000, 232, RIO	**ENT, CNT, DNT**
M4	60 mS	65 mS
M5	60 mS	65 mS
M6	65 mS	70 mS
M8	80 mS	85 mS

Communications

The communications features of the Powermonitor 3000 make it uniquely suited to integrate electric power usage information into your industrial control and information systems. Every Powermonitor 3000 is equipped with a native RS-485 communications port, and you can select optional communications that facilitate seamless integration with a variety of industrial networks. The optional communications choices are:

- *Serial* - an RS-232 communications port
- *Remote I/O* -allows you to connect your Powermonitor 3000 as a quarter rack to any Remote I/O scanner device
- *DeviceNet* - a port with standard DeviceNet functionality lets your Powermonitor 3000 integrate into an open-standard, multi-vendor architecture
- *Ethernet* - a standard 10BaseT port allowing easy integration into factory-floor and office information systems
- *ControlNet* - with NAP port and two BNC connectors for connection to single or redundant media applications

This chapter will cover configuration and operation of the native and optional communications ports. Refer to the Installation Instructions, publication 1404-IN007, for installation, wiring and connection instructions.

Configuring Communications

The Display Module is the recommended way to configure communications on your Powermonitor 3000. If you need to, review Configuration Using the Display Module on page 3-21.

You may also configure communications parameters using the native or optional communications ports. However, because this may lead to loss of communications with the port being configured, we recommend using the Display Module for initial communications configuration. If you choose to configure communications parameters using communications, please refer to Table A.7 Native Communication Configuration and Table A.8 Optional Communication Configuration in Appendix A.

Native RS-485 Communications

Your Powermonitor 3000 is set up to communicate via its native RS-485 port when you first power it up, except for units with an optional RS-232 communication port. The communications configuration includes the following parameters:

- *Protocol:* Allen-Bradley DF1 half-duplex slave, Modbus RTU slave, or auto-sense. Default auto-sense
- *Data rate:* Range 1200, 2400, 4800, 9600, 19,200 baud. Default 9600
- *Delay:* Range 0 to 75 mS, 10 mS default
- *Data Format:* 8 data bits, 1 stop bit, no parity, odd parity or even parity. Default no parity
- *Node address:* Range 1 to 247, default is the same value as the unit ID listed on the nameplate
- *Inter-character timeout*: Range 0 to 6553 msec. Default 0 (= 3.5 character times)

The *Delay* parameter is the time the Powermonitor 3000 waits before its response to an external request. Certain communications equipment requires such a delay for reliable operation.

To change your native port configuration, use the Display Module under the ***PROGRAM*** > ***NATIVE COMMUNICATIONS*** menu.

You may connect your Powermonitor 3000 into an RS-485 network with up to 32 nodes connected with 2-conductor shielded twisted pair cable with a maximum cable length of 1,219 meters (4,000 ft.). The maximum data rate supported by the Powermonitor 3000 is 19.2 Kbaud. You must use a device configured as a master to communicate with this port. Error checking method is CRC (Cyclic Redundancy Check). All devices on the RS-485 network must be set at the same data rate.

TIP The native communications port does not support Data Highway 485 (DH-485) communications. Although DH-485 uses the RS-485 physical media, its protocol is not compatible with the DF1 protocol.

Table 4.1 Native Communication Configuration Summary

Parameter	Description	Range	Default	User Setting
Protocol		DF1 Half-Duplex Slave Modbus RTU Slave Auto-Sense	Auto-Sense	
Delay	Time between receiving a request and transmitting a response	0 to 75 mS	10 mS	
Baud Rate	RS-485 port communications bit rate	1200 baud 2400 baud 4800 baud 9600 baud 19200 baud	9600 baud	
RS-485 Address	Uniquely identifies the Powermonitor device on a multi-drop network	1 to 247	Unit ID number	
Data Format	Data bits / Stop bits / Parity	8 / 1/ none 8 / 1/ even 8 / 1/ odd	8 / 1 / none	
Inter-Character Timeout	Mimimum delay between characters that indicates end of Modbus message packet	0 to 6553 ms	0 (= 3.5 character times)	

Optional RS-232 Communications

Powermonitor 3000 units with a catalog number ending in "-232" are equipped with an optional RS-232 serial port in addition to the native port. These units are set up at the factory to communicate using the optional port using the Allen-Bradley DF1 half-duplex slave protocol. The configuration parameters are:

- *Protocol:* Allen-Bradley DF1 half-duplex slave, Modbus RTU slave, auto-sense. Default auto-sense.
- *Data rate:* Range 1200, 2400, 4800, 9600, 19,200 baud. Default 9600
- *Delay:* Range 0 to 75 mS, 10 mS default
- *Node address:* Range 1 to 247, default is unit ID listed on nameplate
- *Data Format:* 8 data bits, 1 stop bit, no parity or even parity. Default no parity

- *Flow Control:* Enables or disables hardware handshaking. Default disabled
- *Inter-character timeout:* Range 0 to 6553 msec. Default 0 (= 3.5 character times)

To change your RS-232 port configuration, use the Display Module under the ***PROGRAM*** > ***OPTIONAL COMMUNICATIONS*** menu.

The RS-232 communications standard supports point-to-point communications between 2 stations or nodes, with a maximum cable length of 15.24 meters (50.0 ft.). As does the native communications port, the RS-232 port uses CRC error checking. You may not use the optional RS-232 port and the native RS-485 port at the same time.

Table 4.2 Optional RS-232 Communications Configuration Summary

Parameter	Description	Range	Default	User Setting
Port	Select active serial port	RS-232 RS-485	RS-232	
Protocol		DF1 Half-Duplex Slave Modbus RTU Slave Auto-Sense	Auto-Sense	
Delay	Time between receiving a request and transmitting a response	0 to 75 mS	10 mS	
Baud Rate	RS-485 port communications bit rate	1200 baud 2400 baud 4800 baud 9600 baud 19200 baud	9600 baud	
Node Address	Uniquely identifies the Powermonitor device on a multi-drop network	1 to 247	Unit ID number	
Data Format	Data bits / Stop bits / Parity	8 / 1/ none 8 / 1/ even 8 / 1/ odd	8 / 1 / none	
Flow Control (Handshaking)	RS-232 hardware flow control	0 - none 1 - RTS/CTS	0 - none	
Inter-Character Timeout	Mimimum delay between characters that indicates end of Modbus message packet	0 to 6553 ms	0 (= 3.5 character times)	

Optional Remote I/O Communications

Powermonitor 3000 units with a catalog number ending in "-RIO" are equipped with an optional Remote I/O port in addition to the native port. This dual-port option allows the use of both ports simultaneously. The port emulates a logical quarter-rack of I/O. You must configure the rack address, group number, baud rate and last rack status. Configuration parameters are:

- *RIO Rack Address:* The logical rack address as configured in the Remote I/O scanner module. Range 0 to 63 decimal, default 1
- *RIO Group Number:* Logical group number corresponding to the Remote I/O port quarter rack. Range 0, 2, 4 or 6, default 0
- *RIO Last Rack:* If you are using a PLC-2 based system, set this flag for the highest-numbered rack / group addressed device on the channel. Range 0 or 1, default 0
- *RIO Baud Rate:* Sets the communications rate. Range: 57.6, 115 or 230 Kbaud, default 57.6. All devices on the channel must be set to the same baud rate.

TIP For a logical rack address of 63 decimal, do not use group number 2, 4 or 6. Powermonitor 3000 logical rack addresses are expressed in decimal. You may need to convert addresses to octal (range 0 to 77) for some PLC applications.

Use the Display Module under the ***PROGRAM > OPTIONAL COMMUNICATIONS*** menu to set or modify Remote I/O communications parameters.

Table 4.3 Optional Remote I/O Port Configuration Summary

Parameter	Description	Range	Default	User Setting
RIO Rack Address	Logical rack address as configured in the scanner	0 to 63 decimal	1	
RIO Group Number	Logical group number of quarter rack	0 = 1st quarter 2 = 2nd quarter 4 = 3rd quarter 6 = 4th quarter	0 = 1st quarter	
RIO Last Rack	Indicates highest-numbered logical rack / group address (PLC-2 based systems only)	0 = No 1 = Yes	0 = No	
RIO Baud Rate	Specifies the Remote I/O communications rate	0 = 57.6 Kbaud 1 = 115 Kbaud 2 = 230 Kbaud	0 = 57.6 Kbaud	

Optional DeviceNet Communications

Powermonitor 3000 units with a catalog number ending in "-DNT" are equipped with an optional DeviceNet communication port in addition to the native port. Both may operate at the same time. You must configure the DeviceNet communications parameters before you connect the Powermonitor 3000 to a DeviceNet network. Use the Display Module under the *Program* > *Optional Communications* menu. The DeviceNet configuration parameters include node address (or MAC ID), baud rate, and bus-off interrupt response.

- *Node address*: Range 0 to 64, default 63.
- *Baud Rate*: Range 125, 250 or 500 Kbaud fixed rate, AutoBaud or Program Baud. Default 125 Kbaud fixed rate
- *Bus-off Interrupt*: Specifies the response to a CAN bus-off interrupt.

Remotely settable node addressing (node address = 64) enables RSNetworx™ for DeviceNet to configure the node address of the Powermonitor 3000. In addition, this allows client devices that support the DeviceNet Offline Connection Set to identify nodes with duplicate addresses and automatically reassign the addresses of the offending nodes.

AutoBaud allows the Powermonitor 3000 to automatically adjust to the prevailing baud rate of the DeviceNet network. *Program Baud*

enables remote baud rate selection. With this option selected, you may use RSNetworx for DeviceNet to set the Powermonitor 3000 baud rate. Any change in baud rate takes place after power is cycled to the Powermonitor 3000.

Bus-off Interrupt specifies the response of the Powermonitor 3000 to a CAN bus-off interrupt. The two options are *Hold In Reset*, which stops communications until power is cycled to the Powermonitor 3000, and *Reset and Continue*, which resets communications and attempts to re-establish the communications link. Default is *Hold in Reset*.

You must configure each device on a DeviceNet network with a unique node address. Addresses 0 and 64 have special significance: 0 is most often used as a scanner address and 64 enables remotely settable node addressing as described above. You must also configure each device with the correct baud rate for the network. The DeviceNet network must be designed within its recognized design limitations of baud rate, trunk-line length, drop-line budget, and common-mode voltage drop for correct operation.

TIP

Some legacy Powermonitor 3000 units with optional DeviceNet communications do no support remotely settable node addressing, AutoBaud or Program Baud. You can check whether your Powermonitor 3000 supports these functions by viewing the Optional Communications Card status using your Display Module. Communications type 81 will not support these functions, type 88 will. You may also view this status item by a read of assembly instance 23, element 25.

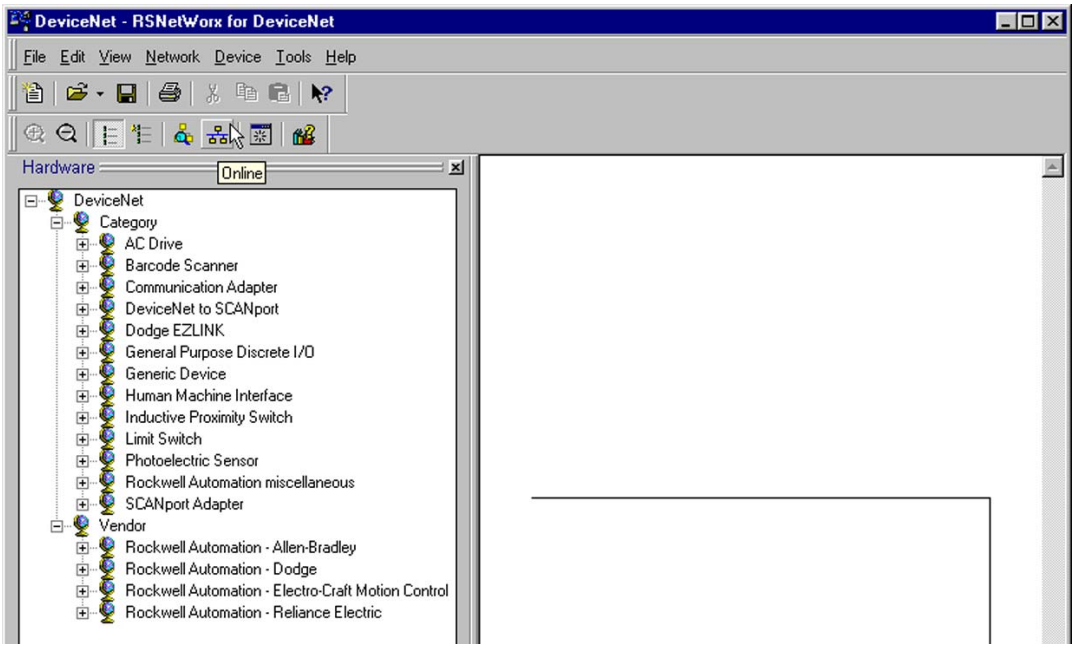
Table 4.4 Optional DeviceNet Communications Configuration Summary

Parameter	Description	Range	Default	User Setting
Node Address	DeviceNet node number (MAC ID)	0 to 64 decimal	63	
Baud Rate	DeviceNet Communications Rate	0 = 125 Kbaud 1 = 250 Kbaud 2 = 500 Kbaud 3 = Autobaud 4 =Program Baud	0 = 125 Kbaud	
Bus-off Interrupt	Specifies response to a CAN bus-off interrupt	0 = Hold CAN chip in reset 1 = Reset CAN chip and continue	0 = Hold in Reset	

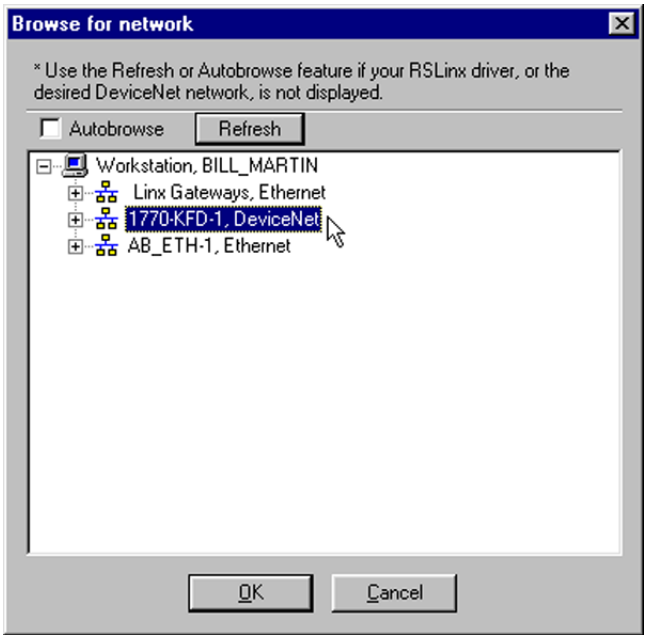
Configuring the Powermonitor 3000 using RSNetworx for DeviceNet

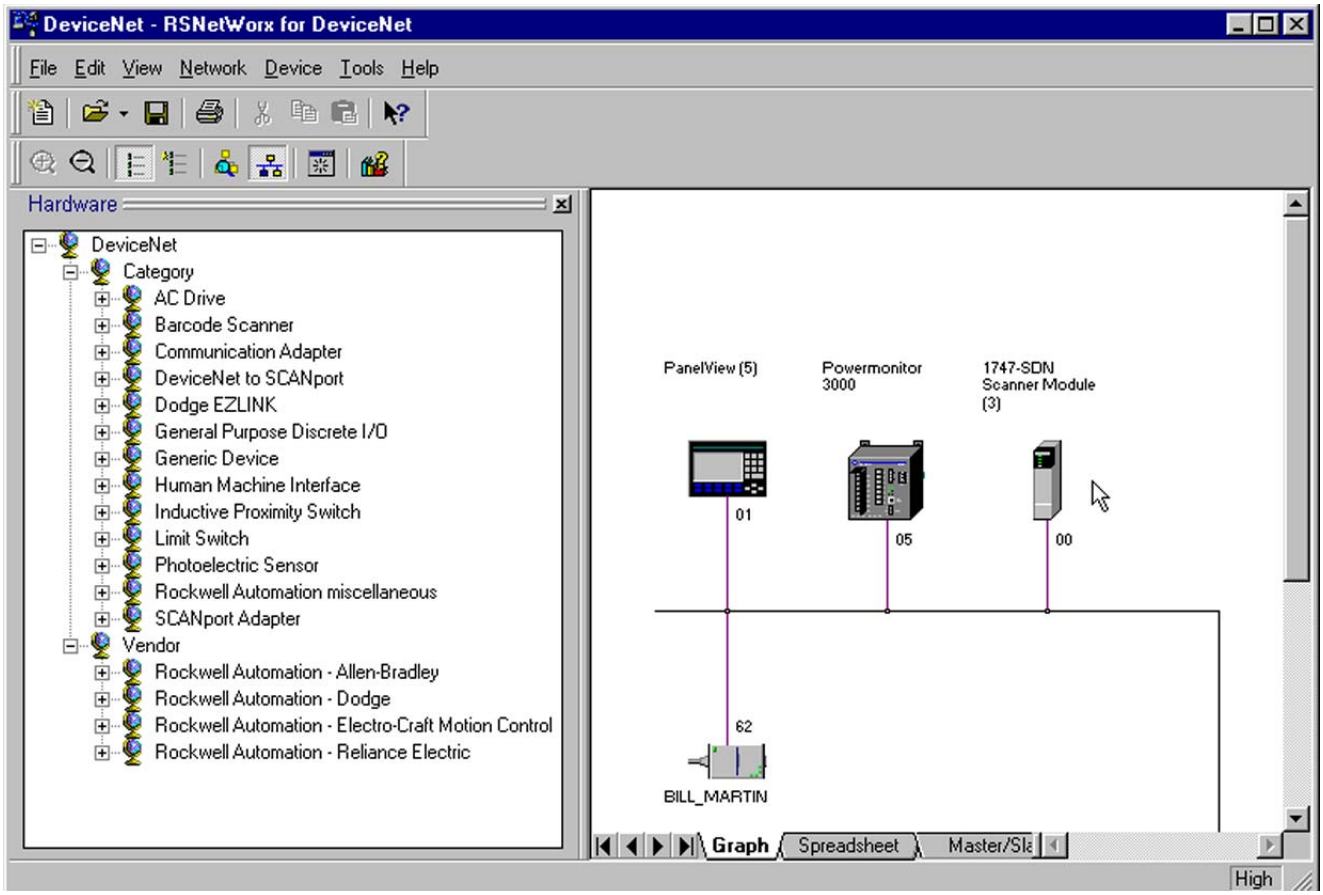
TIP DeviceNet is an open-standard, multi-vendor communications network. Although other vendors offer DeviceNet configuration tools, all examples in this manual will depict the use of Rockwell Software RSNetWorx for DeviceNet.

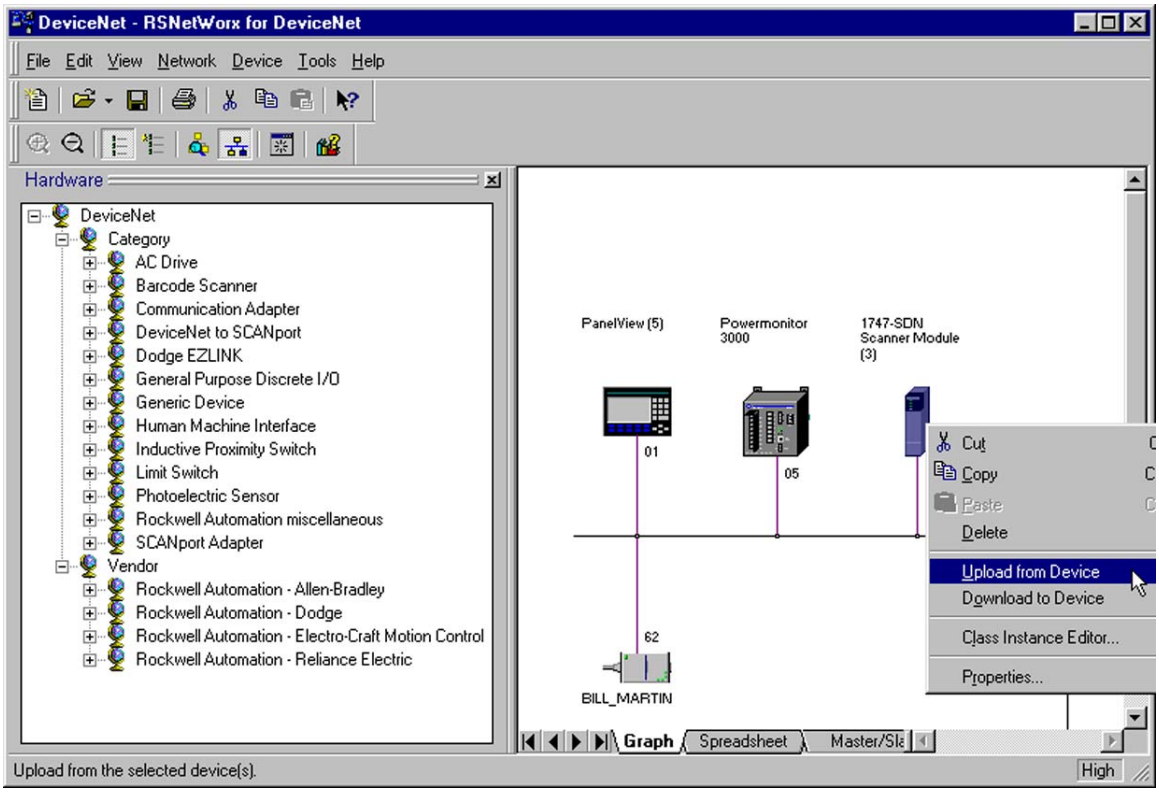
1. Launch RSNetWorx.



2. At this point, the DeviceNet scanner module does not know what device to scan. Click on the Online Button to list the available devices on the network.

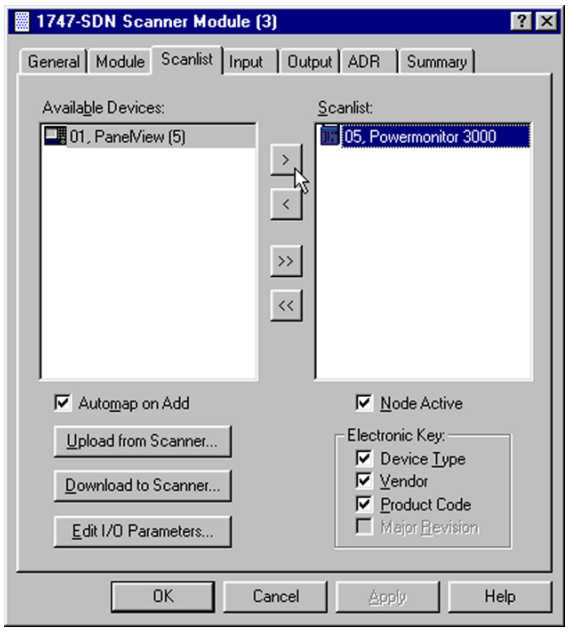






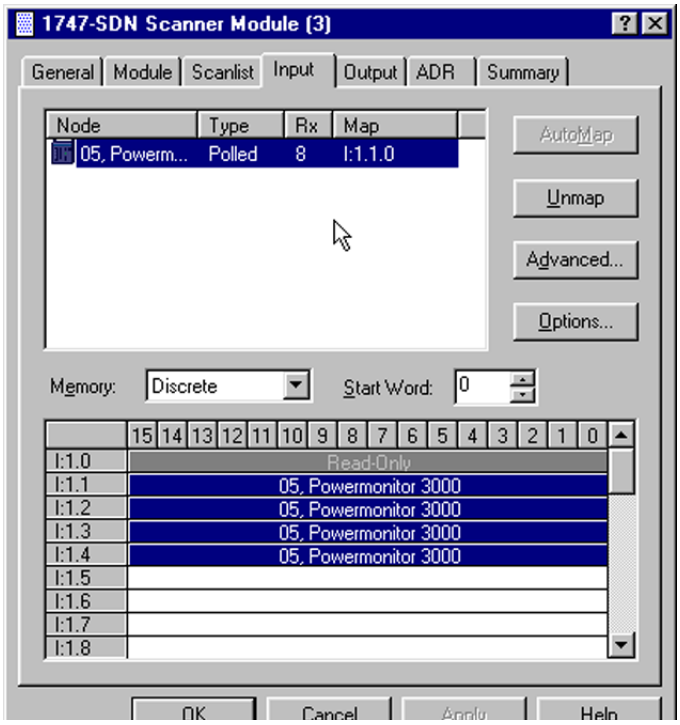
3. Read the scanner's configuration.

   Right click on the DeviceNet scanner icon and upload the scanner's present configuration.



4. Edit the Scanner List

The DeviceNet scanner needs to know how the information is coming from the Powermonitor 3000. Select the *Scan List* tab and move the Powermonitor 3000 into the Scanlist set.



5. Edit the Data Table Map

The DeviceNet scanner needs to know which bytes will be scanned from the Powermonitor 3000. Select the *Input* tab.

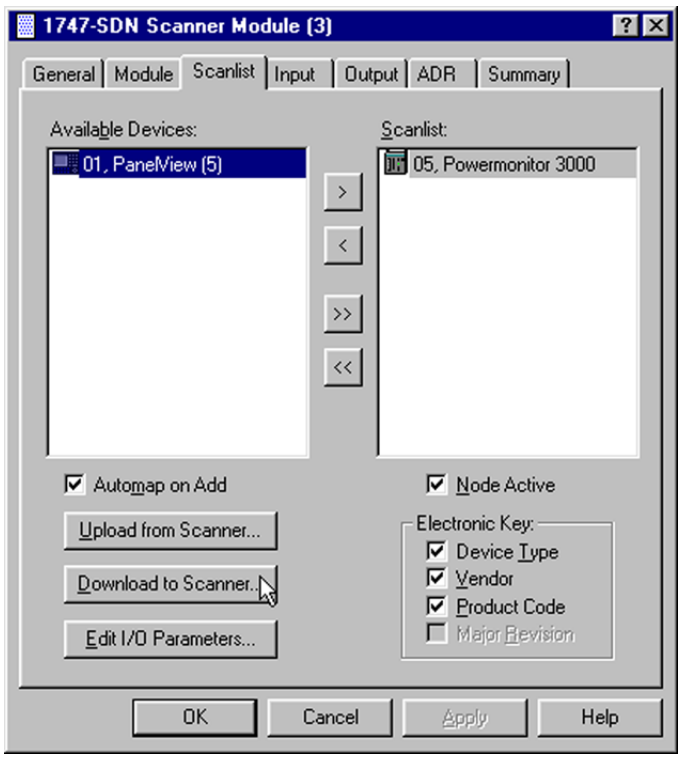
This allows the user to determine where the information is stored inside the scanner module. When finished configuring, select the *Apply* button.

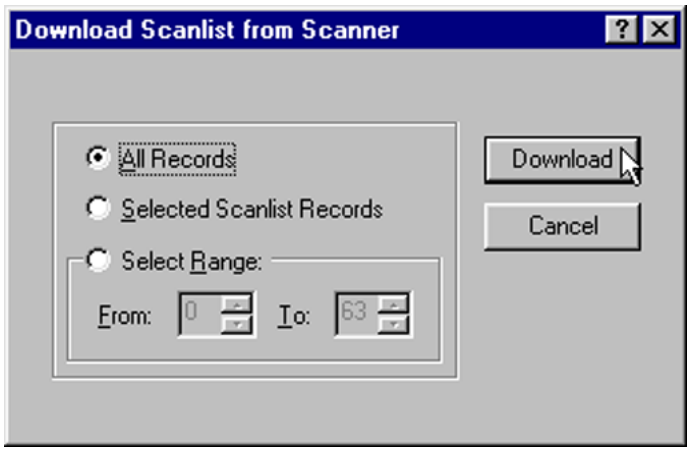
6. Download Configuration to the Scanner

All of the configuration data must be downloaded to the scanner module. Select the *Save to SDN* button, download *All Records*, and allow the scanner to reset.

Afterwards, the DeviceNet Scanner displays an 80, followed by a 00 when everything is configured properly.

TIP Input parameters for Powermonitor 3000 are Instance 1 and output parameters are Instance 2.





Optional Ethernet Communications

Powermonitor 3000 units with a catalog number ending in "-ENT" are equipped with an optional Ethernet 10BaseT communication port and a native RS-485 port in a dual-port configuration that allows simultaneous operation of the ports. You must configure the communications parameters before you connect your Powermonitor 3000 to an Ethernet network. Use the Display Module under the ***PROGRAM > OPTIONAL COMMUNICATIONS*** menu. See your network administrator for assistance in setting the communications options.

Configuration parameters include:

- IP (Internet Protocol) address
- Subnet Mask
- Gateway IP address
- Keep-alive Time (Series A only)
- Protocol Select (Series A only)

The *IP Address* uniquely identifies your Powermonitor 3000 on the network. You configure the unit's IP address the way it is most commonly expressed, as four decimal numbers connected by decimal points: *aaa.bbb.ccc.ddd*. You may set each number (also called byte or octet) within the range of 0 to 255 decimal. The default IP address is 128.1.1.*x*, where *x* is the factory-assigned Unit ID number. A Powermonitor 3000 (Series A, only) with an IP address of 0.0.0.0 will get its operating IP address, subnet mask and gateway IP address from a bootp server on power-up. An IP address of 255.255.255.255 is not permitted.

IMPORTANT The IP address for your Powermonitor 3000 must not conflict with the IP address of any other device on the network. Contact your network administrator to obtain a unique IP address for your unit.

The IP address is a 32-bit binary number, which consists of the network address ("NetID") and the machine address ("HostID"). The *Subnet Mask* defines the boundary between the NetID and HostID in the IP address. Each "1" bit in the subnet mask represents the NetID and each "0" represents the HostID. Here is an example:

IP Address	(decimal):	192	.1	.1	.207
	(binary):	11000000	.00000001	.00000001	.11001111
Subnet Mask	(decimal):	255	.255	.255	.0
	(binary):	11111111	.11111111	.11111111	.00000000
		--------	Net ID	--------	-Host ID-

In this example, the NetID is 192.1.1.0 and the HostID is 0.0.0.207. The relationship between NetID and HostID depends on the IP address class, the discussion of which is beyond the scope of this document (the example uses a Class C IP address). Devices on the same subnet can communicate directly; devices on different subnets may communication with each other only through a gateway or router.

The *Gateway IP Address* defines the address of the gateway or router on the unit's subnet that is used to route messages to other subnets for wide-area networking. Default: 128.1.1.1.

If the *IP address* is set to 0.0.0.0, any user settings for *Subnet Mask* and *Gateway IP Address* are ignored and these parameters are obtained from a bootp server (Series A, only).

Keep Alive Time (Series A only) defines the maximum time that the unit keeps a socket dedicated to a connection that is not responding. The unit probes inactive connections at this rate and closes the connection if the remote device does not respond within 8 probes. The range is 0 to 3,600 seconds; default is 30 seconds. 0 disables sending of Keep Alive packets.

The *Protocol Select* parameter (Series A only) determines which protocol the Ethernet port uses. Choices are: 0, for CSP and CIP dual-stack; 1 for CSP only; and 2 for CIP only. CSP is the client/server protocol (also called PCCC) used by some legacy Allen-Bradley PLC-5 and SLC 500 controllers. CIP is the control and information protocol that underlies EtherNet/IP, ControlNet and DeviceNet communications. EtherNet/IP is an open standard used by a number of suppliers. The default setting is 0, dual stack CSP and CIP (Series B only supports CIP).

Table 4.5 Optional Ethernet Communications

Parameter	Description	Range	Default	User Setting
IP Address Bytes 1 to 4	Unit IP address in format aaa.bbb.ccc.ddd. 0.0.0.0 enables bootp	0 to 255 decimal, each byte	128.1.1.Unit ID	
Subnet Mask Bytes 1 to 4	Subnet mask in format aaa.bbb.ccc.ddd	0 to 255 decimal, each byte	255.255.255.0	
Gateway IP Address Bytes 1 to 4	Gateway IP address in format aaa.bbb.ccc.ddd	0 to 255 decimal, each byte	128.1.1.1	
Keep Alive Time	Used to close out inactive connections	0 to 3600 seconds	30 seconds	
Protocol Select (Series A only)	Selects the Ethernet protocol used	0 = CSP / CIP 1 = CSP only 2 = CIP only	0 = CSP / CIP	

Optional ControlNet Communications

Powermonitor 3000 units with a catalog number ending in "-CNT" are equipped with an optional redundant ControlNet port and a native RS-485 port in a dual-port configuration that allows simultaneous operation of the ports. You must configure the communications parameters before you connect the Powermonitor 3000 to a ControlNet network. Use the Display Module under the ***PROGRAM > OPTIONAL COMMUNICATIONS*** menu.

The only configuration parameter is the ControlNet node number (also called MAC ID). The range of this parameter is 1 to 99 with a default of 99. A node number of 0 is typically used as the address of a ControlNet scanner.

Data Messaging Overview

Through communications, the Powermonitor 3000 becomes an effective source of power and energy data to enterprise information and automation systems. This section of the manual provides an overview of data messaging with the Powermonitor 3000. Following the overview, discussions will focus on the details of messaging using specific communications types (e.g. serial, Remote I/O, DeviceNet and Ethernet).

The Powermonitor 3000 is a read/write data server. It does not initiate data messages, but responds to messages from client devices. Its data is organized in data tables similar to those found in a SLC 5/03 programmable controller.

Four primary methods to communicate with a Powermonitor 3000 are:

- *Table Writes* - A client may write a table of data to the Powermonitor 3000. Only full data tables may be written. Data writes may be performed to configure device features, set the date and time, reset or preset energy counters, and select records for subsequent reads.
- *Simple Data Reads* - A client may read metering or configuration data. The client may read an entire data table or any number of consecutive data elements up to the table boundary.
- *Indexed Data Reads* - The Powermonitor 3000 parses large data structures such as logs, oscillograms, harmonics and transient captures into data blocks, records and/or channels. These records are transferred to an interface table. The client selects the read-back mode and/or record, reads the interface table and reassembles the original data structure.
- *I/O Type Communications* - The Powermonitor 3000 supports polled, change-of-state and/or cyclical implicit I/O messaging, depending on the communications options.

The specific communications setup depends on the communications port type and protocol, whether serial, Ethernet, etc., as well as the type of device controlling the communications. The following sections will provide more detail.

Powermonitor 3000 Data Table Attributes

Powermonitor 3000 data table attributes include their addressing, data access, number of elements, data type, and user-configurability.

Address - Data tables are addressed in a number of ways, depending on the type of communications and the protocol being used.

- For serial communications (native RS-485 and optional RS-232) and optional Ethernet CSP/PCCC communications, the CSP (Client Server Protocol) File Number identifies the table (and its data type) in message instructions, topic configuration or communications commands.

IMPORTANT CSP file numbers are based on SLC 5/0x data table addressing. Because SLC 500 data tables 1 through 8 are assigned specific data types, file numbers lower than 9 are not used in the Powermonitor 3000.

- For Remote I/O communications, a unique *Block Transfer Size* identifies the data table to read or write using a *Block Transfer* instruction.
- For optional DeviceNet and EtherNet/IP communications, a CIP (Control and Information Protocol) Assembly Instance identifies the data table.

Data Access - Data tables may be read-only or read/write.

Number of Elements - the number of unique data values contained in the table. The number of words or bytes this represents depends on the data type.

Data Type - Specified as floating-point or integer. Each floating-point element consists of two 16-bit words or four 8-bit bytes of data. Each integer element consists of one word or two bytes.

User-configurability - This attribute determines whether the user may configure the content and/or length of the data table.

Let's look at the *Date and Time* table as an example:

- CSP file number: N11
- Remote I/O BT length: 12
- CIP assembly instance: 6 (Write) or 7 (Read)
- Data table name: Date & Time
- Data access: Read/write
- Number of elements: 8
- Data type: Integer
- User-configurable: No

The Powermonitor 3000 data tables are listed in Appendix A. Table A.1 in shows a summary of all the data tables.

Expressing Data in Data Tables

The Powermonitor 3000 may express metering data in several formats in the communications data tables.

Floating-point data type is used to express most metering results. The trend log, min/max log and the user-defined data table also return values in floating-point format. The Powermonitor 3000 uses the IEEE 754, 32-bit floating-point format that is compatible with Allen-Bradley PLC-5 and SLC 500 controllers.

Modbus float data type returns IEEE 754 floating point values in a big-endian two-register array.

Integer data type (16 bit) is used in most configuration data tables and some results data tables.

Integer array format is used to express real, reactive and apparent energy results. Each of these values is expressed as an array of five integer values, each scaled by a different power of ten (10^9, 10^6, 10^3, 10^0, 10^{-3}). Refer to Table A.14 Metering Real and Apparent Energy Results on page A-22 for additional detail.

Integer/exponent format is used for some specific table entries such as IEEE-519 short-circuit current. The integer element is in the range of 0 to 999 or 9999 and a typical exponent element ranges from -4 to 21.

Timestamp format. The Powermonitor 3000 expresses timestamps in an array of four data table elements: *Year*, *Month/Day*, *Hour/Minute*, *Second/ Hundredth* of a second

Each timestamp parameter (except the *Year*) is a combination of its first and second element. For instance, the *Month* is the parameter value divided by 100 and the remainder is the *Day*. Example: 1230 = December 30th. The timestamp data type may be integer or floating-point and depends on the data table.

Other common data table elements

The Powermonitor 3000 uses several common data table elements in a number of data tables. These include:

- *Password:* A valid password must be written to change configuration settings or issue commands. For selecting records to read back, you may write either a valid password or a value of -1. Default 0000, range 0000 to 9999.

- *Record identifier:* The Powermonitor 3000 assigns event log records, oscillography and transient captures and other items unique identification numbers. These numbers typically begin at 0, increment by 1 each time a new record is created, and roll over to 0 once they reach their maximum value, typically 32,767. The data client may use the record identifier to associate records in different data tables or to ensure that subsequent reads contain fresh data.
- *DeviceNet unique write identifier:* The DeviceNet communications port on Powermonitor 3000 models so equipped will discard duplicate identical messages. For that reason, read-back selection tables include a *DeviceNet unique write identifier* element. The data client changes (usually, increments) the value of this element each time it writes an otherwise identical message.

Writing Data to Data Tables

The Powermonitor 3000 contains a number of writeable data tables. These tables have read/write access, so a client may read their current content or write new content.

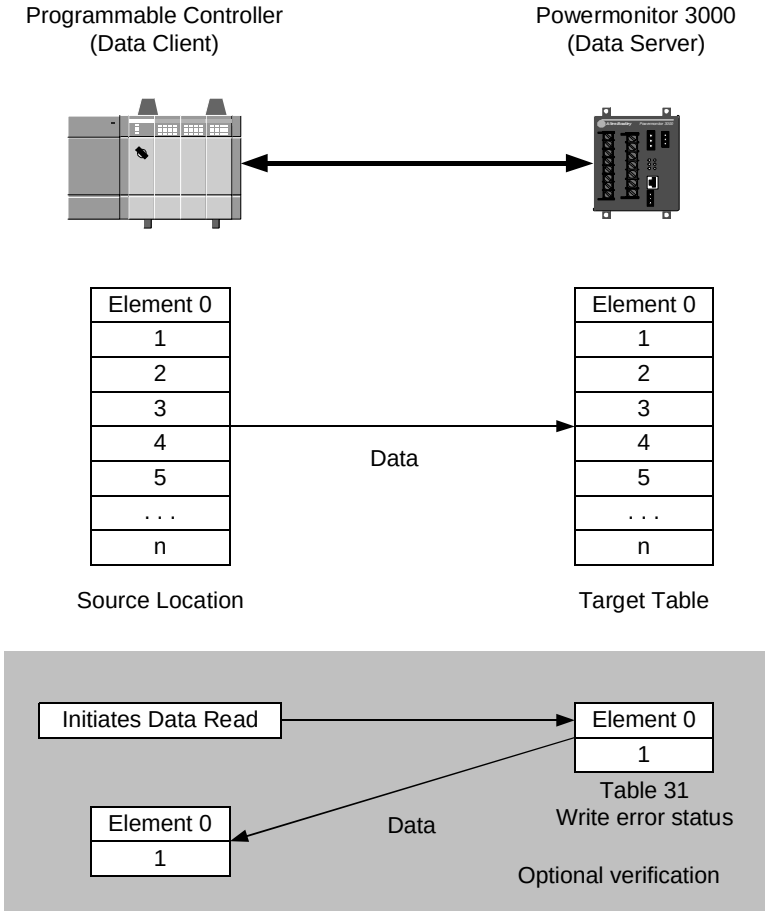
A valid write to a data table must meet the following general criteria:

- The length of the source data array must equal the data table length. Note that the same data table may have a different length in various Powermonitor 3000 models
- The entire data table must be written in one pass
- The first element in the source data array must generally contain the correct password (or a value of -1 for read-back data selection)
- The source and destination data type must match, e.g. floating point or integer
- Each element of the source data array must be within the legal range listed in the data table specification
- Reserved elements must be the correct value, usually 0
- For DeviceNet optional communications only, each consecutive write must be unique.

You may read the *Write Error Status* table after writing to a data table to verify that the write was valid and accepted by the Powermonitor 3000. If there was an error in the last write, the Write Error Status will indicate the CSP file or assembly instance (DeviceNet only) number and the offending element number.

You may write data to the Powermonitor 3000 for basic and advanced device configuration, to set the time and date, to set up setpoints, logs, oscillography and transient analysis, and to select records to be read back from indexed data reads such as harmonics, oscillography and logs.

Figure 4.1 Data Table Write Flow Diagram



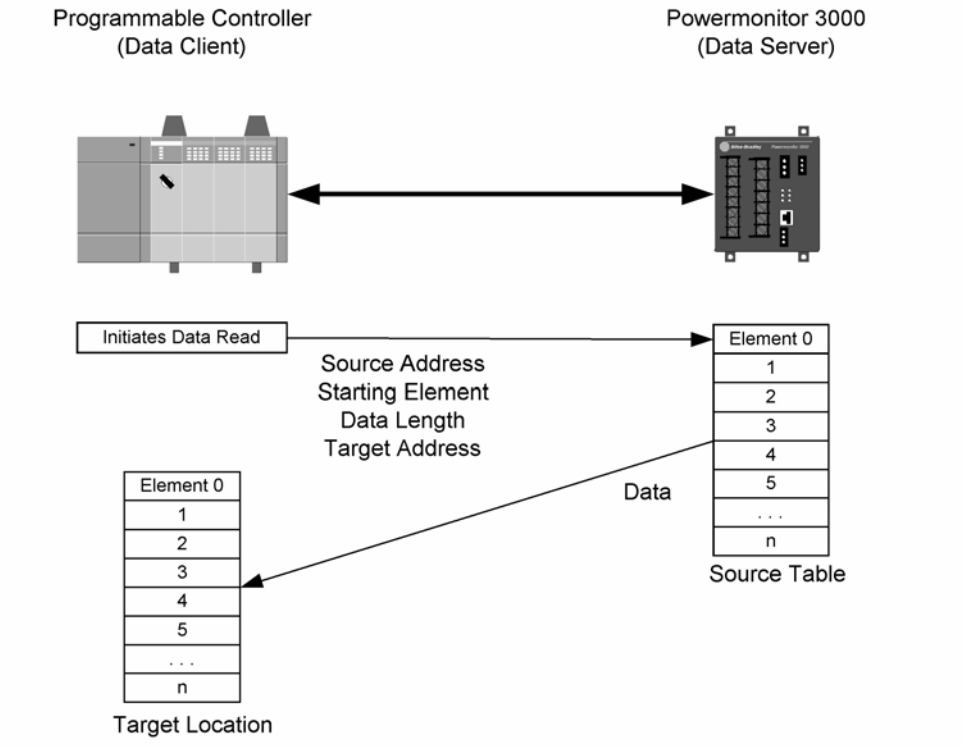
Simple Reads of Data Tables

The following considerations apply to simple Powermonitor 3000 data table reads:

- An entire data table or a contiguous portion (down to a single element) may be read, except for Remote I/O and DeviceNet optional communications which require that an entire table be read
- The target data location should match the size and data type of the data requested

  You may use simple reads to obtain basic metering data, configuration data, date and time, and the contents of the user-configured data table.

Figure 4.2 Simple Data Table Read Flow Diagram



Indexed Reads of Large Data Structures

Large data structures that require indexed reads are most often read into a computer-based application that performs further processing of the data. The Powermonitor 3000 parses logs, oscillograms, harmonic analysis results, setpoint status results, and other large data structures into individual records to be read by the client and reassembled into the original data structure.

You may select one of two modes for indexed table reads.

- *Auto Increment* - the Powermonitor 3000 automatically points to the next record following each read of the specified results table
- *Manual Increment* - the client specifies a record to be read during the next read of the results table by performing a write to the applicable read-back select table.

IMPORTANT Ethernet and DeviceNet communications options support only manual increment mode.

The client selects the read-back mode by writing to the *Read-back Mode* element in the appropriate read-back select table.

For native RS-485, optional RS-232 or optional Remote I/O, the auto-increment mode provides the highest data throughput.

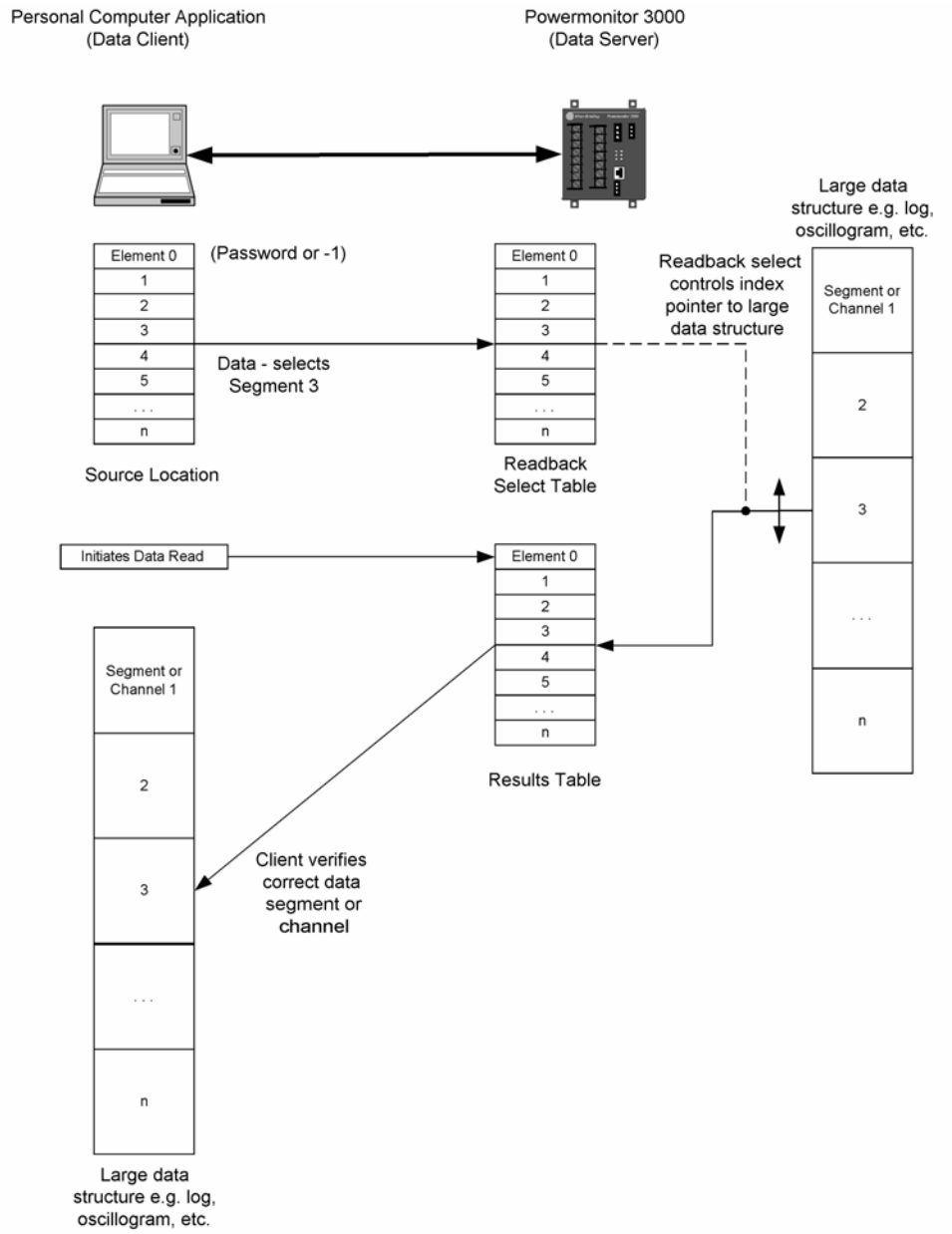
In manual increment mode, the client must alternate writes of the read-back select table with reads of the read-back table. Figure 4.3 shows the flow of alternating writes and reads required for the manual increment mode.

1. The client writes to the appropriate read-back select table to identify the desired data block, record or channel. For selecting a read-back record, the client may write either a valid password or a value of -1 to the password element in the read-back select table

2. After a short time delay, the client reads the results table, verifies that it is the desired record and adds it into the target data structure.

3. The client repeats steps 1 and 2 until all the desired data is read.

Figure 4.3 Indexed Data Read, Manual Mode Flow Diagram



Refer to Chapter 5, Setpoint Programming and Operation; Chapter 7, Data Logging; and Chapter 8, Advanced Features for details of indexed mode data reads for each of these functions.

I/O Type Communications

Powermonitor 3000 units with optional Remote I/O, EtherNet/IP (Series B) and DeviceNet communications provide I/O type messaging.

Remote I/O units emulate a logical quarter rack on the I/O channel. The corresponding, two-word output and input image table elements are automatically scanned by the I/O scanner, and the data points they contain are available for use in the logic program of the controller associated with the I/O scanner.

In DeviceNet units, Instances 1 and 2 comprise the DeviceNet polled, change-of-state or cyclic connections. The default input table contains 6 integer typed elements and the output table contains two integer typed elements. You may configure instance 1. Refer to the User-configured I/O table discussion below.

In EtherNet/IP (Series B) units, Instances 1 and 2 comprise the Class 1 connection. As in DeviceNet units, Instance 1 contains 6 integer elements of input data and Instance 2 contains 2 integer elements of output data. You may configure Instance 1. Series A Ethernet units do not support a Class 1 (I/O) connection.

Refer to Table A.2 Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging on page A-4 for the content and format of the I/O messaging data tables.

Data Messaging-Application Considerations

The Powermonitor 3000 supports a number of different communications networks and protocols. Each of these has unique characteristics and methods. The information in this section is provided to assist you in designing and implementing data messaging with the Powermonitor 3000 by discussing in detail the unique properties of the communications options. Refer also to the Sample ladder diagrams in Appendix C.

Serial Communications Options

The native RS-485 and optional RS-232 communications ports provide basic serial asynchronous communications capabilities. Both the RS-485 and optional RS-232 ports may be selected as Allen-Bradley DF1 half-duplex slave, Modbus RTU slave or auto-sense, which selects the protocol based on detection of incoming packets. Powermonitor 3000 units with master module firmware earlier than version 2.5x support only DF1.

The RS-485 communications standard supports multi-drop communications between a master station and up to 31 slaves on a single network up to 1219 meters (4000 feet) long. For satisfactory communications performance, however, we recommend connecting no more than 8 to 12 Powermonitor 3000 units to an RS-485 multi-drop network.

The optional RS-232 communications port has several configuration settings that support the use of modems for point-to-point and point-to-multipoint communications. You may select Hardware Handshaking (CTS/RTS) and adjust the Delay parameter to match your choice of modem hardware. Please refer to Configuring Optional RS-232 Communications for detailed information on these settings.

The Powermonitor 3000 does not initiate messages nor does it support modem dial-out capabilities.

Allen-Bradley DF1 protocol

The Allen-Bradley DF1 half-duplex slave protocol is supported by a number of Rockwell Automation and third party products. Please refer to publication 1770-6.5.16, DF1 Protocol and Command Set Reference Manual, for further information.

The Powermonitor 3000 serial ports do not support DF1 full-duplex communications or Data Highway 485 (DH-485) communications.

The network master device must be configured as a DF1 polling master. All devices on the network must be set to the same baud rate. The node addresses of the Powermonitor 3000 units must be listed in a permanent or temporary polling list of the master device, and the error checking must be set to CRC. When communications is established, the RS-485 or RS-232 RX and TX status LEDs will flash alternately at a rapid rate. If you are using Rockwell Software RSLinx™ as a polling master, the Powermonitor 3000 will appear in RSWho™ if it is defined in the polling list. For best communications performance using RSLinx, keep the number of concurrent clients to a minimum (for example, turn off the auto-browse function in RSWho).

To communicate with an Allen-Bradley PLC-5, SLC 500 or ControlLogix controller, use message instructions that address the DF1 master port number, the Powermonitor 3000 node address, the Powermonitor 3000 data table address, (e.g. F17:0 - Metering Power Results), and the length of the file in elements. The target file must be of the same data type as the Powermonitor 3000 data table, e.g. integer or floating-point.

IMPORTANT Because the floating-point word order in the ControlLogix controller is reversed from that in the Powermonitor 3000, your ladder logic will need to reverse the word order so the data may be interpreted correctly. The swap byte (SWPB) instruction performs this function.

Because of the DF1 protocol's inherent handshaking, the completion of each message may be used to activate the next message, without any additional programmed delay.

Modbus RTU slave protocol

We assume that the user is familiar with Modbus communications. The information provided in this section is general, rather than specific. Refer to glossary at the end of this publication for definitions of unfamiliar terms. For more information about the Modbus RTU Slave protocol, see the Modbus Protocol Specification (available from http://www.modbus.org)

Modbus is a half-duplex, master-slave communications protocol. The network master reads and writes coils and registers and obtains diagnostic information of the multiple slaves. The Modbus protocol allows a single master to communicate with a maximum of 247 slave devices (however no more than the physical limitations of the RS-485 or RS-232 ports permit). The master device on a Modbus network is not assigned an address.

Modbus messages are always initiated by the master. The slave nodes will never transmit data without receiving a request from the master node. The slave nodes will never communicate with each other. The master node initiates only one Modbus transaction at a time.

The Powermonitor 3000 supports Modbus RTU, the version of Modbus applied to serial communications in which each byte of data consists of 2 hexadecimal values. Modbus ASCII, Modbus Plus and Modbus TCP are not supported.

The Powermonitor 3000 does not initiate Modbus commands but responds to commands sent by the Modbus master. The following Modbus function codes are supported:

- 03 Read Holding Registers
- 04 Read Input Registers
- 16 Write Multiple Holding Registers

- 08 Diagnostics
  - 00 Echo Command Data
  - 02 Return Diagnostic Counters
  - 10 Clear Diagnostic Counters
- 06 Write Single Holding Register

Function 06, 16 and the sub function 10 of function 08 support Broadcast packets.

Refer to Appendix A for Modbus addresses of the Powermonitor 3000 data tables. The Powermonitor 3000 supports zero-based addressing. The address ranges are arranged as follows (note that not all addresses in the range are used):

- 30001 – 40000 Modbus Input Register (Analog Input) Address Space
- 40001 – 50000 Modbus Holding Register (Analog Output) Address Space

The Modbus protocol supports four types of data: Discrete Input, Coil, Input Register and Holding Register. The Powermonitor 3000 supports Input Registers (read-only) and Holding Registers (read-write or write only).

Input Registers and Holding Registers are 16 bits long. Floating point values in the data tables are represented as big-Endian two-register arrays in IEEE-754 floating point format. The Modbus client application must be able to reassemble the two-word array into a valid floating-point value.

The Powermonitor 3000 return the Modbus error codes shown in the table below when appropriate. In the event of an exception reply, not only will the exception code be sent to the master device, but also the Powermonitor 3000 slave's diagnostic counter will record the error code to further explain the error reason.

The data table number of error request and element offset of error request in Table A.32 Write Error Status is updated with the first Modbus address of the table and element offset that the incoming request packet attempts to write to.

Error Code	Description	Meaning	Response Exception Code
0	No error.		None.
1	Function Code cannot Broadcast.	The function does not support Broadcast.	Nothing transmitted
2	Function Code not supported.	The controller does not support this Modbus function or sub-function.	1
3	Bad Command Length	The Modbus Command is the wrong size.	3
4	Bad Length	The function attempted to read/write past the end of a data file.	3
5	Bad Parameter	The function cannot be executed with these parameters.	3
6	Bad Table Number	The table number does not exist.	2
7	Bad Modbus Address	The function attempted to access an invalid Modbus address.	3
8	Table Write Protected	The function attempted to write to a read-only table.	3
9	Table Access Denied	Access to this table is not granted.	2

If a client device requests too large a data size, the Powermonitor 3000 returns the requested data padded with zeroes up to the requested data size rather than returning an error.

When Table A.30 User-Configured Table Setup is used together with Modbus, the value for element 1 should be 1000.

The value for element 0 of Table A.32 Write Error Status will be the first Modbus address of data table written to last.

For function code 03, 04 and 16, the number of words of user data is limited to 100. If it is over 100, exception code 3 will be returned to the master and error code 3 occurs.

For function code 16, if the data length is larger or less than the element number of the data table accessed, error code 4 will occur. It means the data length for function code 16 should be strictly the same as the size of the accessed data table.

If the data written to Powermonitor 3000 by using function code 16 is outside of the legal range as shown in Appendix A, error code 5 will occur.

For function code 03, 04 and 16, if any undefined starting address is sent to the Powermonitor 3000, exception code 2 will be returned and error code 6 will occur. If the starting addresses other than the first Modbus address of the data tables are sent to the slave with function code 16, this error code will also occur.

For function codes 03 and 04, the starting address may be any address within the data table. However, for floating point data tables, one element occupies two Modbus addresses. Therefore, only odd Modbus address are allowed when accessing floating point data table. If the starting address is even, error code 7 will occur.

Table A.53 Controller Command is the only one table that has write only attribute. If the user tries to use function code 03 to read this table, error code 8 will occur and a 02 exception response packet will be returned.

Auto-sense protocol selection

The primary purpose for auto-sense is to permit configuration using RSPower32 on a point-to-point RS-485 connection by disabling the Modbus master station and enabling a DF-1 polling master in RSLinx. The port switches back to the Modbus protocol when it detects incoming Modbus data packets. Simultaneous use of Modbus and DF-1 master stations on the same network is not permitted or supported.

When auto-sense is selected, when a port configured as Modbus detects incoming DF-1 half-duplex data packets, it automatically switches to the DF-1 half-duplex protocol at the same baud rate and other communications parameters. The port may return a communications error to the first non-selected packet and then switch protocols. The client should be set up to retry communications if it receives an error.

DeviceNet Communications Option

The Powermonitor 3000 with optional DeviceNet communications operates as a slave device on a DeviceNet network. It will serve data to a DeviceNet master station such as a PLC-5 or SLC 500 DeviceNet scanner, a ControlLogix DeviceNet bridge module, a PanelView operator terminal and RSLinx direct and pass-thru DeviceNet drivers. It supports I/O (implicit) Messaging, Explicit Server Messaging and the explicit Unconnected Message Manager (UCMM) as discussed below.

I/O Messaging

The Powermonitor 3000 supports polled, change-of-state and cyclic I/O messaging using assembly instances 1 for input data and 2 for output data. The default input messaging table size is 6 integer elements and the output table size is 2 integer elements. This corresponds to a DeviceNet scanner mapping of 12 Rx and 4 Tx bytes. See Table A.2 on page A-4 for the contents of the default I/O messaging tables.

TIP You may reconfigure the input messaging table (instance 1) by selecting up to 23 integer or 14 floating-point parameters through a table write to assembly instance 35. Refer to User-configured I/O on page 4-54. If you change the size of the input table, you must also re-map the inputs into the DeviceNet scanner using RSNetworx for DeviceNet.

Polled I/O messaging can automatically provide fresh data at update rates as fast as 100 mS. The Powermonitor 3000 supports both *Every Scan* and *Background* polled messaging. You select the poll type and polling rate using RSNetworx for DeviceNet software.

- *Every Scan:* Polls the Powermonitor 3000 once per scan. Set the *Interscan Delay* to at least 100 mS. An *Interscan Delay* of less than 100 mS will slow the Powermonitor 3000's delivery of metering information.
- *Background:* Polls the Powermonitor 3000 at intervals you specify using the Foreground to Background Poll Ratio. So long as the Powermonitor 3000 is polled no more frequently than every 100 mS, it will operate and communicate at its optimal rate. You may calculate the total scan time with this formula:

$$\text{Total Scan Time} = (1 + R) \bullet D$$

Where:
R = Foreground to Background Poll Ratio
D = Interscan Delay

Change of State I/O messaging (COS) reports data only when the content of the I/O table changes. COS messaging can be more efficient for discrete applications because it tends to reduce the network traffic. If you have configured the input message table to include metering data, however, COS may reduce the network efficiency because the data constantly changes.

Cyclic I/O messaging reports data periodically according to a time increment you configure.

COS and Cyclic messaging typically reduce the network bandwidth loading compared with Polled messaging. To optimize explicit messaging performance, use a *Background Polled* I/O connection with a high foreground to background poll ratio.

To help obtain optimal network operation, verify the following settings using RSNetworx for DeviceNet, looking at the scanner *Properties* dialog:

- For *Polled* I/O messaging, verify that the effective polling rate (or scan time) is less than the expected packet rate (EPR) to prevent time-out errors. You may find the EPR on the *Module* tab, *Advanced* button.
- For *COS* or *Cyclic* I/O messaging, verify that the COS/Cyclic Inhibit Time is less than the EPR and that the ACK time out is set appropriately. You may find these parameters on the *Scanlist* tab, *Edit I/O Parameters…* button.

Please contact Rockwell Automation technical support if you find that the default settings do not result in adequate network performance.

Explicit Messaging

Use explicit messaging to read and write all data tables other than the I/O messaging table. The specific details of explicit messaging depend upon the master device that initiates the message. The example in this section uses an Allen-Bradley SLC 500 controller and DeviceNet Scanner (1747-SDN) as the master. Refer to the DeviceNet Scanner Module Installation Instructions, publication 1747-5.8, for a detailed description of explicit message programming in the SLC 500. Please refer to the Rockwell Automation Knowledge Base for other examples of explicit messaging to a Powermonitor 3000.

In the SLC 500 and PLC-5, you assemble the explicit message header in an integer file and transfer it to the scanner module. When the response is received, you transfer the response from the scanner to another integer file. The message header consists of 6 words organized as follows:

Table 4.6

Message	Word	High byte	Low byte
Header	0	Transmit ID	Command
	1	Port	Size
	2	Service	MAC ID
Body	3	Class	
	4	Instance	
	5	Attribute	
	6	Data to write if applicable	
	7		
	. . .		
	n		

Word 0 contains a transmit identifier (TXID) and command byte. Assign each explicit message a unique TXID in the range of 0 to 255 decimal (0 to FF hex). The TXID is used to identify the response to this message request. Valid command codes are:

- 1 hex = Execute transaction block. Use this command first to start the explicit message.
- 4 hex = Delete transaction from response queue. Use this command after you copy the response from the scanner to remove the response from the scanner and enable further explicit messages.

Word 1 contains the DeviceNet scanner port number and the transaction body size in bytes. The SLC 500 scanner uses only port 0; a PLC-5 DeviceNet scanner has two ports, 0 and 1. For a read request, the transaction body size is 3 words (see table above) therefore 6 bytes. For a write, the body size is the data size in bytes plus the 6-byte path (class/instance/attribute).

Word 2 contains the DeviceNet service code and the MAC ID or node number of the server device, in this case, the Powermonitor 3000. Valid service codes for use on Class 4 assembly instances are:

- 0E hex (14 decimal) = Get_Attribute_Single. Requests a read of the entire assembly instance defined in the transaction body.
- 10 hex (16 decimal) = Set_Attribute_Single. Writes the data contained in the message to the assembly instance defined in the transaction body.

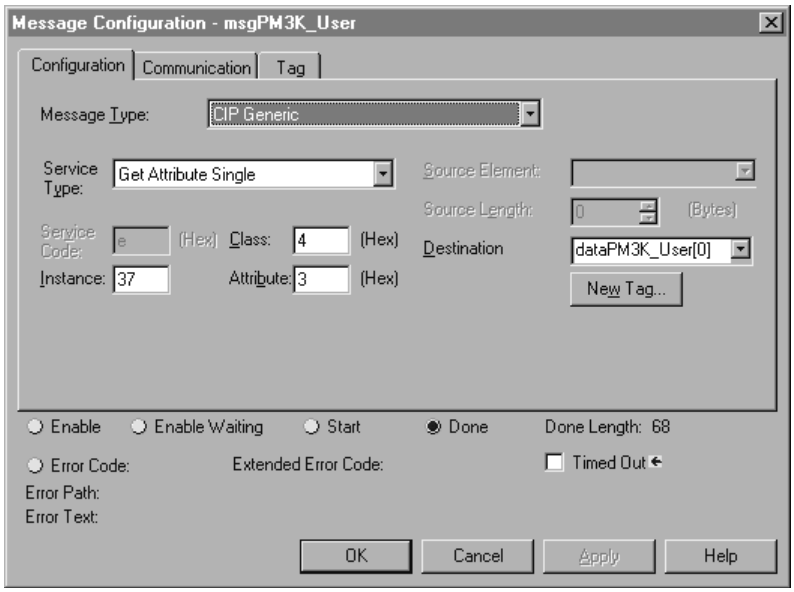
TIP A convenient way to build Words 0, 1 and 2 is to multiply the high byte value by 256 and add the low byte value, using decimal values for each parameter. Example: TXID = 121; Command = 1. Word 0 = 121*256 + 1 = 30977.

Words 3 through 5 comprise the DeviceNet path: Class, Instance, and Attribute. For the Powermonitor 3000 data tables, Class = 4, Assembly Objects; Attribute identifies the data table, and Attribute = 3, data.

Word 6 and following words contain data to write to the Powermonitor 3000.

Once the message is assembled, your ladder program transfers the integer file to the scanner module M0 file starting at word 224 (SLC 500) or block transfers the 64-word integer file to the scanner module (PLC-5).

The ControlLogix controller includes in its instruction set a CIP Generic message instruction that builds the transaction header and path from information you enter into the message setup dialog in RSLogix 5000.



The example above is a ControlLogix message instruction to read the user-configured table, assembly instance 37.

TIP Because the floating-point word order in the ControlLogix controller is reversed from that in the Powermonitor 3000, your ladder logic will need to reverse the word order so the data may be interpreted correctly. The SWPB instruction performs this function.

Up to four concurrent explicit messaging connections are supported by the DeviceNet communications port.

DeviceNet Message Types

The Powermonitor 3000 supports the following message types:

Table 4.7 DeviceNet Message Types

Group	CAN Identifier Field	Message Type
1	01101xxxxxx	Slave's I/O COS or Cyclic message
	01111xxxxxx	Slave's I/O poll response or COS / Cyclic ACK message

Table 4.7 DeviceNet Message Types

Group	CAN Identifier Field	Message Type
2	10xxxxxx010	Master's COS / Cyclic ACK message
	10yyyyyy011	Slave's explicit / unconnected response message
	10xxxxxx100	Master's explicit request message
	10xxxxxx101	Master's I/O poll command / COS / Cyclic message
	10xxxxxx110	Group 2 only unconnected explicit message request
	10xxxxxx111	Duplicate MAC ID check message
3	11101xxxxxx	Unconnected explicit response
	11110xxxxxx	Unconnected explicit request
4	Not used	

xxxxxx = Destination MAC ID / node no. (6-bit field)

yyyyyy = Source MAC ID / node no. (6-it field)

DeviceNet Class Services

As a group 2 slave device, the Powermonitor 3000 supports the following class and instance services.

Table 4.8 DeviceNet Class Services

Service Name	Service Code (hex)	Service Code (decimal)
Reset	05	05
Get_Attribute_Single	0E	14
Set_Attribute_Single	10	16
Allocate_Group_2_Identifier_Set	4B	75
Release_Group_2_Identifier_Set	4C	76

DeviceNet Object Classes

The Powermonitor 3000 supports the following DeviceNet object classes:

Table 4.9 DeviceNet Object Classes

Class (hex)	Object
01	Identity
02	Message Router
03	DeviceNet
04	Assembly
05	Connection
2B	Acknowledge handler

Indexed Data Table Reads using DeviceNet

Powermonitor 3000 units with optional DeviceNet communications support only manual-indexed mode for reading large data structures such as oscillograms, setpoint status, logs and harmonics. Refer to the appropriate sections of this manual for detailed information.

DeviceNet Unique Write Identifier

The communications interface used in the DeviceNet communications option is programmed to reject duplicate write messages. Because of this, all writeable data tables in the Powermonitor 3000 include an element called *DeviceNet unique write identifier*. In many cases, your client application may ignore this element because the message data is unique. However, where your client application performs repeated identical writes, it should increment the DeviceNet Unique Write Identifier with each new message. An example of this would be reading the Event Log or Trend Log.

Ethernet Communications Option

The Powermonitor 3000 with optional Ethernet communications operates as a slave device on the Ethernet network. Its built-in web server provides access to metering and status data using only your web browser.

The Ethernet port supports up to 64 concurrent connections. It employs an algorithm to release inactive connections after a user-configurable time.

Ethernet communications functionality differs significantly from Series A to Series B. Table 4.9 summarizes the differences.

IMPORTANT Please give particular attention to the messaging and software version compatibility information in the table. If you are replacing a Series A Ethernet Powermonitor 3000 with a Series B unit, you may need to upgrade software or modify the communications programming of your controller ladder programming or client application to re-establish communications.

Table 4.10 Series A and Series B Comparison

Function	Series A (Comms FRN 2.01 or 2.02)	Series B
Communications protocol	CSP (PCCC) and/or EtherNet/IP	EtherNet/IP only Encapsulated PCCC (Comms FRN 1.22 or later)
Protocol select	Yes	N/A
Bootp support	Yes	No
Data rate	10 Mbps	10/100 Mbps
Web page	Fixed web page	Configurable web page
Flash upgradeable	Uses special loader	Uses ControlFlash
LED indicators	Link, RX, TX	LNK, ACT, STATUS`
Network Demand Synch	No	Yes
SNTP capable	No	Yes
I/O Communications	No	Yes
CIP Generic messaging	Yes	Yes
PLC-5 Typed CIP messaging	Yes	Yes
CIP Data Table messaging	Yes	Yes, Comms FRN 1.21 or later
SLC 500 Typed CIP messaging	Yes	Yes, Comms FRN 1.21 or later
RSPower32 support	2.10 and later	2.40 and later
RSEnergyMetrix support	Yes	Yes
RSEnergy support	2.00.13 (CSP only)	No, upgrade to RSEnergyMetrix

The Powermonitor 3000 supports the following network requests:

Table 4.11 Ethernet Message Types

Message type	Series A	Series B
CIP PLC-5 Typed Write	•	•
CIP PLC-5 Typed Read	•	•
CIP Generic Assembly Object (class 04), Get & Set Attribute Single for Attribute 3 (data)	•	•
CIP Generic Assembly Object (class 04), Get Attribute Single for Attribute 3 (size)	•	•
CIP SLC 500 Typed Write	•	(1)
CIP SLC 500 Typed Read	•	(1)
CIP Data Table Read (using CSP/PCCC addressing e.g. F15:0)	•	(1)
CIP Data Table Write	•	(1)
CSP / PCCC PLC-5 Typed Write	•	(2)
CSP / PCCC PLC-5 Typed Read	•	(2)
CSP / PCCC Protected Typed Logical Read, 2 address fields	•	(2)
CSP / PCCC Protected Typed Logical Read, 3 address fields	•	
CSP / PCCC Protected Typed Logical Write, 2 address fields	•	(2)
CSP / PCCC Protected Typed Logical Write, 3 address fields	•	
CSP / PCCC Word Range Read		(2)
CSP / PCCC Word Range Write		(2)
CSP / PCCC Diagnostic Loopback	•	

(1) Available in communications FRN 1.21 or later.

(2) Available in communications FRN 1.22 or later. Uses CIP Encapsulation on PCCC commands.

Ethernet PCCC/CSP protocol

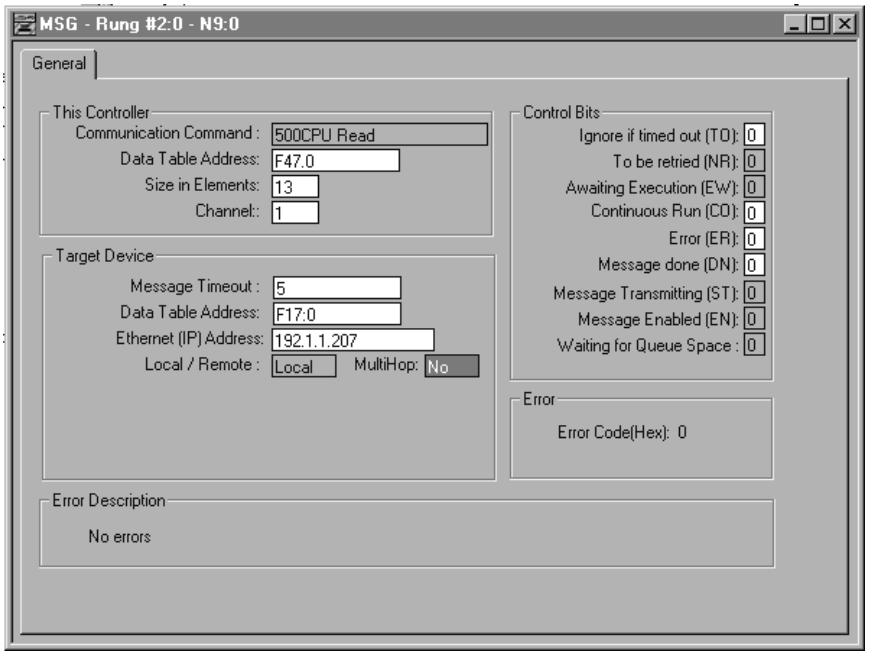
PCCC messaging is supported in the Series A Powermonitor 3000 and in Series B units with communications firmware 1.22 and Master Module firmware 2.5x or later.

IMPORTANT For future compatibility, it is recommended that you use EtherNet/IP messaging with Series A Powermonitor 3000 units.

You may set up messaging from legacy controllers such as PLC-5 and SLC 500, to a Powermonitor 3000 with optional Ethernet

communications, using peer-to-peer message instructions. In the message setup, specify the controller data table address, size of the data in elements and the channel the message instruction is to use. For the target device (Powermonitor 3000), specify its IP address and data table address. In the example message setup dialog below, the SLC 500 controller is reading the Power table (F17:0) from a Powermonitor 3000 with IP address 192.1.1.207.

Figure 4.4 SLC 5/05 to Powermonitor 3000 Message Detail Screen Example



If you want to execute a sequence of messages, condition each message in the sequence with the previous message's done or error status, and include a brief programmed time delay between messages so that each message receives fresh data and the communications port is not overloaded. As a starting point, program the inter-message time delay at the nominal update rate of the Powermonitor 3000 (see page 3-33).

For PCCC/CSP messaging, set the Optional Communications Protocol configuration (Series A only) to either CSP or CSP/CIP. Neither a Series A Powermonitor 3000 with protocol set to CIP only nor a Series B Powermonitor with comms firmware 1.21 or earlier will respond to messages using the PCCC/CSP protocol.

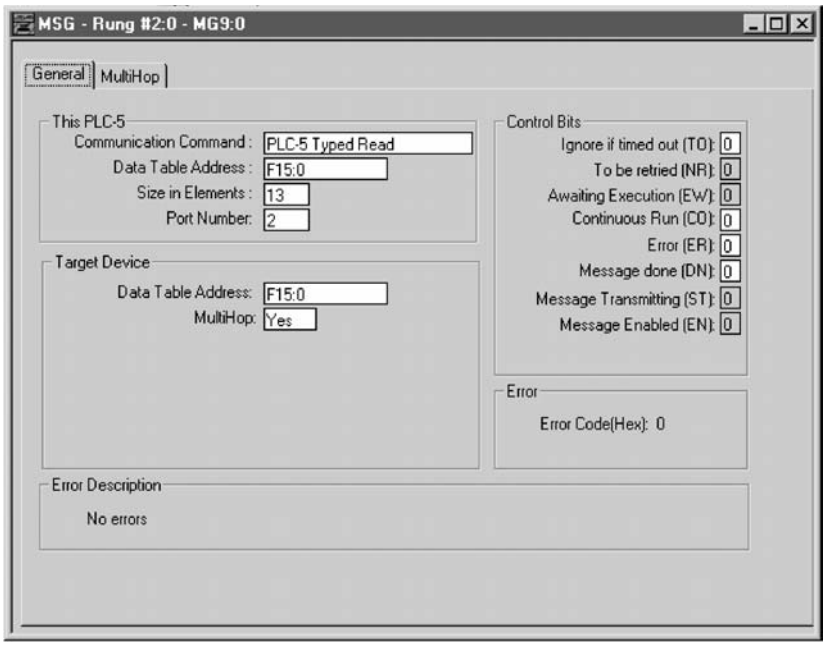
EtherNet/IP (CIP) Protocol

Allen-Bradley controllers since the release of the ControlLogix platform have used the EtherNet/IP or CIP protocol. In particular, PLC-5 and SLC 5/05 controllers at or later than the following series and revision levels support CIP communications:

- PLC-5/xxE Series C/ Rev. N
- PLC-5/xxE Series D/ Rev. E
- PLC-5/xxE Series E/ Rev. D
- SLC 5/05 Series A FRN 5 (OS 501)
- SLC 5/05 Series C

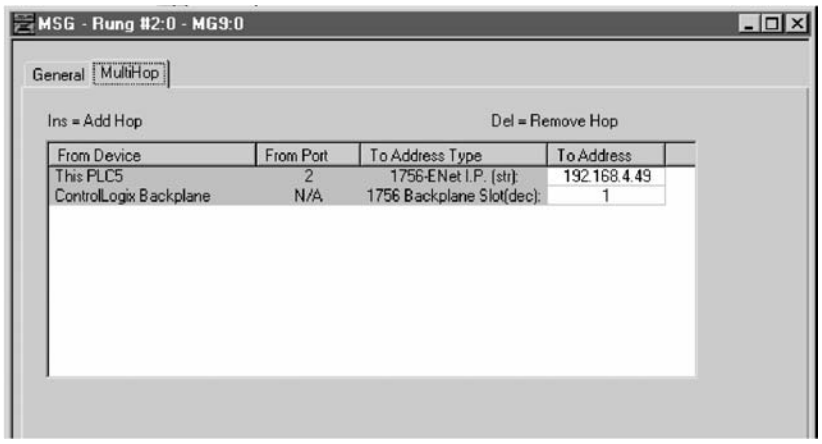
Messaging from a PLC-5E or SLC 5/05 to a Powermonitor 3000 uses a MultiHop message path. The client controller "thinks" it is communicating with a ControlLogix controller. The example message detail screens below indicate a PLC/5xxE reading the voltage and current table F15:0 from a Powermonitor 3000 to the controller's F15:0 data table.

Figure 4.5 PLC-5/xxE Message Detail Screen Example



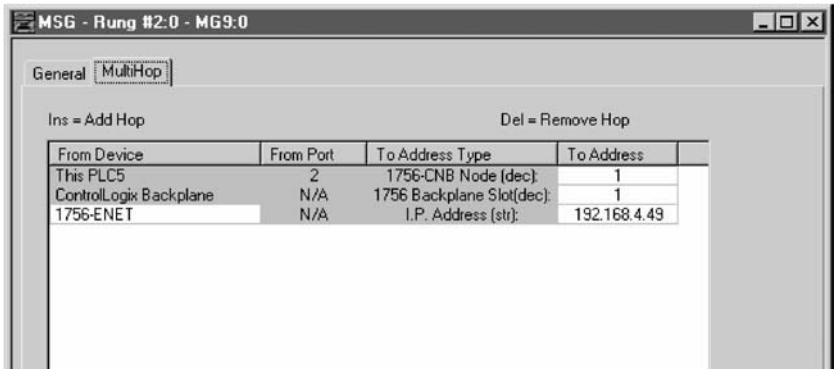
When you select *Yes* in the *MultiHop* field, the *MultiHop* tab appears in the dialog. Enter the IP address of the Powermonitor 3000 in the *1756-ENET I. P.* field (192.168.4.49 is used here as an example) and any integer in the 1756 backplane *Slot* field. See below.

Figure 4.6 PLC-5/xxE MultiHop Configuration



The example below shows the MultiHop configuration for messaging from a PLC-5/xxC ControlNet processor through a ControlLogix Gateway to an Ethernet Powermonitor 3000.

Figure 4.7 PLC-5/xxC via ControlLogix Gateway MultiHop Configuration

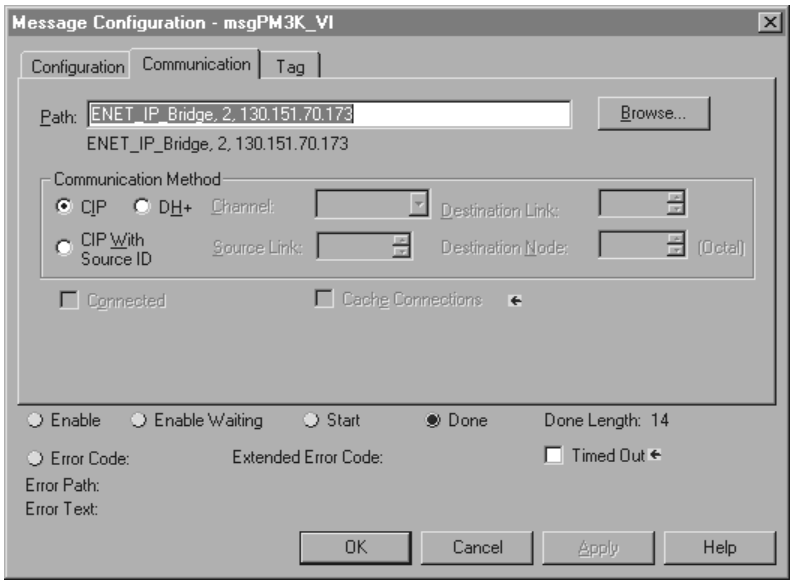


You may choose between two types of ControlLogix to Powermonitor 3000 messaging:

- PLC-5 Typed read or write, which encapsulates a PCCC message within a CIP wrapper
- CIP Generic messaging which uses the CIP class/instance/attribute object model common to DeviceNet

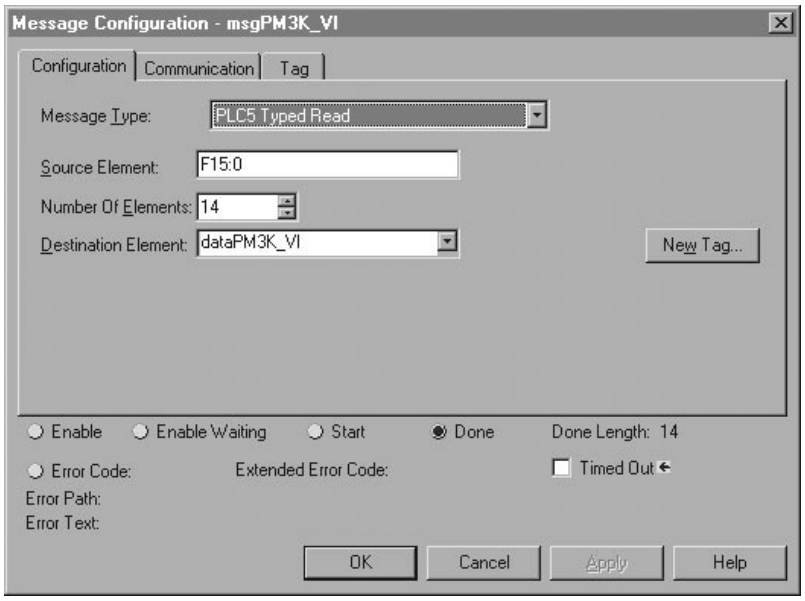
Set up the Communication tab in the ControlLogix message instruction the same for each messaging type, as shown in the first example below:

Figure 4.8 ControlLogix to Powermonitor 3000 Communication Tab Example



The first example below reads the Voltage and Current table from a Powermonitor 3000 into the ControlLogix controller tag *dataPM3K_VI(0)* using a *PLC-5 Typed Read*, configured as an array of 14 elements of type *Real*. You would configure a *CIP Data Table Read* the same way except for the message type.

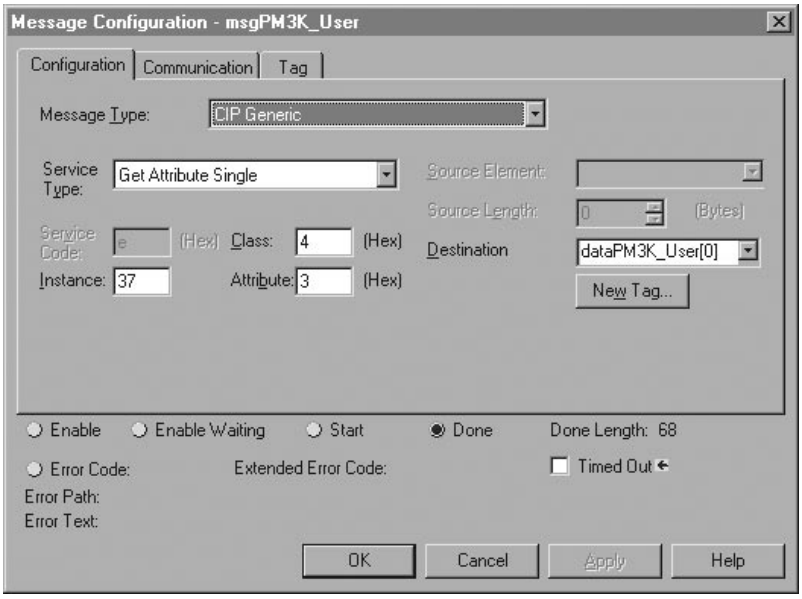
Figure 4.9 ControlLogix PLC-5 Typed Read Example



The next example shows the message configuration for a CIP Generic message type. A CIP Generic message can read or write data, depending on the *Service Type* you specify. Refer to DeviceNet class services in the discussion above. In this example, the ControlLogix

reads the User Configured Data Table into tag *dataPM3K_User(0)*, configured as an array of 23 elements of Real type.

Figure 4.10 ControlLogix CIP Generic Messaging Example



This example uses the following message parameter values:

- *Service Type:* Get_Attribute_Single, (service code oe hex)
- *Object class:* 4 (hex), Assembly
- *Instance:* 37 (decimal), User configured table results
- *Attribute:* 3 (hex), Data

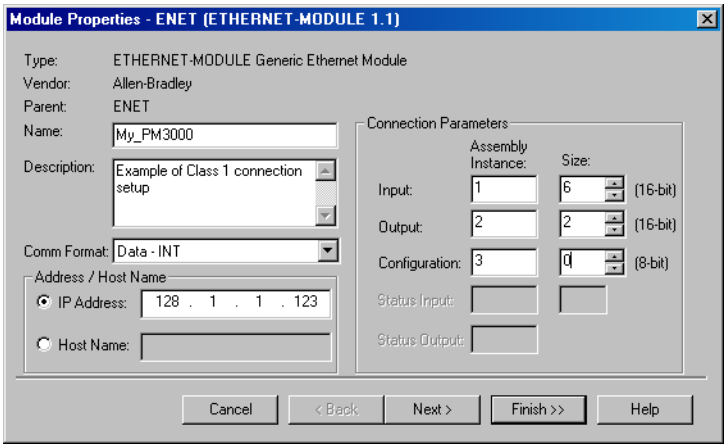
EtherNet/IP I/O Connection (Series B only)

Series B Powermonitor 3000 Ethernet units support a Class 1 connection to Instance 1 and 2. To utilize this scheduled connection to a ControlLogix controller, open the controller program offline in RSLogix 5000. Select the 1756-ENET/B or 1756-ENBT/A module in the I/O configuration. Add the Powermonitor 3000 as a Generic Ethernet Module. Figure 4.11 shows a typical configuration.

TIP

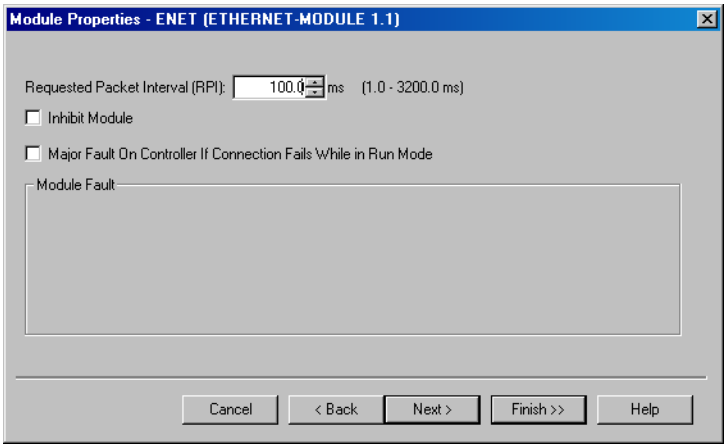
If you wish to establish a Class 1 connection with more than one controller to the same Powermonitor, use instance 1 and 2 for the first controller and use instance 1 and 99 for all remaining controllers (instance 99 is a placeholder instance since instance 2 only supports one connection).

Figure 4.11 I/O Connection Setup



Select 'Data – INT' as the Communications Format. Enter the IP address of the Powermonitor 3000. Set the Connection Parameters as shown for the default configuration. If you change the configuration of the input assembly instance, enter its new size in Instance 1 here. Select 3 as the Configuration instance and leave its Size set to 0 bytes (the Series B Powermonitor 3000 does not support a Class 1 configuration connection). Click the Next> button.

Figure 4.12 Requested Packet Interval Setup


Module Properties - ENET (ETHERNET-MODULE 1.1)
Requested Packet Interval (RPI): 100.0 ms (1.0 - 3200.0 ms)
Inhibit Module
Major Fault On Controller If Connection Fails While in Run Mode
Module Fault
Cancel
< Back
Next >
Finish >>
Help

Set the Requested Packet Interval to 100 mS or greater. The Powermonitor 3000 will not respond reliably to an RPI of less than 100 mS.

The Powermonitor 3000 data will be found in controller tags as shown in Figure 4.13.

Figure 4.13 Powermonitor 3000 I/O Tags

My_PM3000:C	{...}	{...}		AB:ETHERNET_...
My_PM3000:I	{...}	{...}		AB:ETHERNET_...
My_PM3000:I.Data	{...}	{...}	Decimal	INT[6]
My_PM3000:I.Data[0]	0		Decimal	INT
My_PM3000:I.Data[1]	0		Decimal	INT
My_PM3000:I.Data[2]	0		Decimal	INT
My_PM3000:I.Data[3]	0		Decimal	INT
My_PM3000:I.Data[4]	0		Decimal	INT
My_PM3000:I.Data[5]	0		Decimal	INT
My_PM3000:O	{...}	{...}		AB:ETHERNET_...
My_PM3000:O.Data	{...}	{...}	Decimal	INT[2]
My_PM3000:O.Data[0]	0		Decimal	INT
My_PM3000:O.Data[1]	0		Decimal	INT

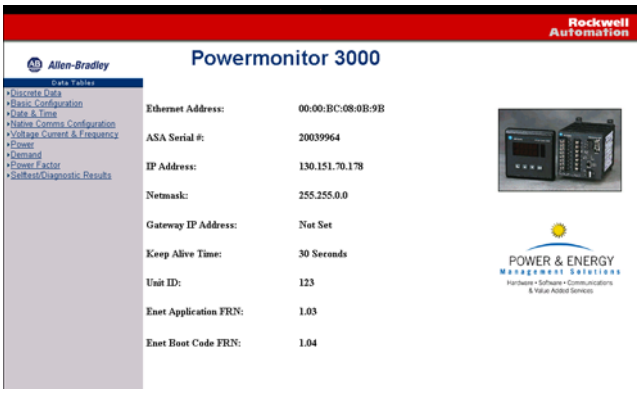
Powermonitor 3000 Web Access

You may view a number of data tables by simply pointing your web browser to the IP address of your Powermonitor 3000 from a computer with access to the unit's subnet. Example: http://192.1.1.207.

On the left side of the web page is a list of data table that you may view. Each list entry is a hyperlink that takes you to the selected table with a single mouse click. Each table appears as a tabular display with value descriptions and values. To return to the main page, click the *Refresh* button on your browser.

The Series B Powermonitor 3000 web page may be configured. Contact Rockwell Automation for more information.

Figure 4.14 Powermonitor 3000 Web Page



Additional Ethernet Information

The Powermonitor 3000 utilizes the following fixed Ethernet port numbers:

- HTML: Port 80
- CSP: Port 2222
- CIP: Port 44818

For More Information

For related documentation on Ethernet and EtherNet/IP communications, please see the following internet websites:

- http://www.ab.com/networks/whatnew.html#ethernet
- http://www.ietf.cnri.reston.va.us/
- http://www.standards.ieee.org/catalog/olis/lanman.html
- http://www.controlnet.org

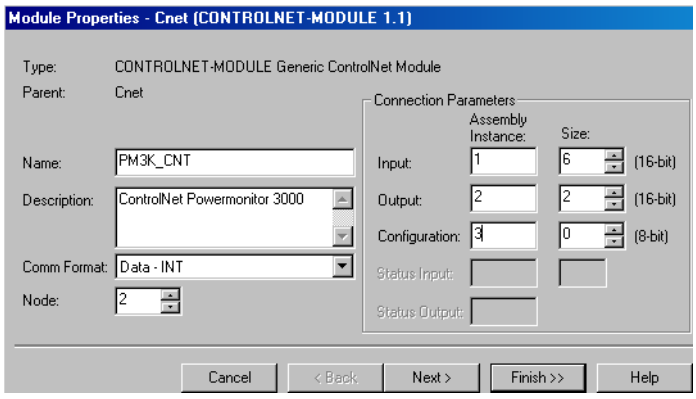
For additional information on the TCP/IP protocol, networking in general, and EtherNet/IP please see these publications:

- Comer, Douglas E., *Internetworking with TCP/IP, Volume 1: Protocols and Architecture*, Prentice-Hall, Englewood Cliffs, NJ, 1990. ISBN 0-13-468505-9
- Tenenbaum, Andrew S., *Computer Networks, 2nd Edition*, Prentice-Hall, Englewood Cliffs, NJ, 1989. ISBN 0-13-162959-X
- *ControlNet Specifications*, ControlNet International, Ltd., Clearwater, FL, 2001.

ControlNet Communications Option

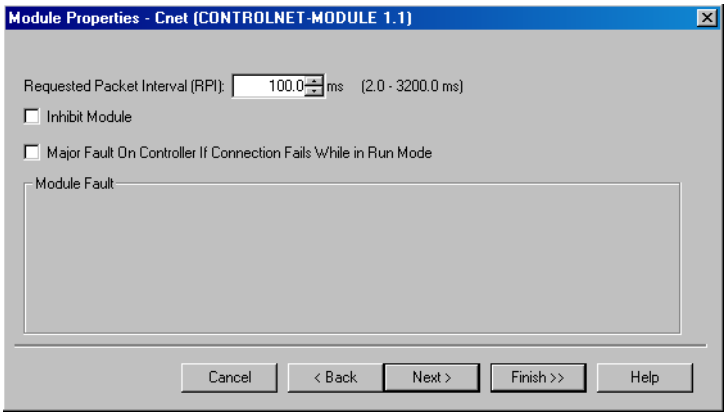
Powermonitor 3000 ControlNet units support a Class 1 connection to Instance 1 and 2. To utilize this scheduled connection to a ControlLogix controller, open the controller program offline in RSLogix 5000. Select the ControlNet bridge module (1756-CNB or 1756-CNBR) in the I/O configuration. Add the Powermonitor 3000 as a Generic ControlNet module. Figure 4.15 shows a typical configuration.

Figure 4.15 ControlNet Configuration



Select “Data-INT” as the Communications Format. Enter the ControlNet address of the Powermonitor 3000. Set the Connection Parameters as shown for the default configuration. If you change the configuration of the input assembly instance, enter its new size in Instance 1 here. Select 3 as the Configuration instance and leave its Size set to 0 bytes. Click the Next> button.

Figure 4.16 Requested Packet



Set the Requested Packet Interval to a binary multiple of the network update time (NUT) greater than 100 mS. The Powermonitor 3000 update rate is typically 100 mS.

The Powermonitor 3000 data will be found in controller tags as shown in Figure 4.17.

Figure 4.17 Controller Tags

PM3K_CNT:I.Data	{...}	{...}	Decimal	INT[6]
PM3K_CNT:I.Data[0]	0		Decimal	INT
PM3K_CNT:I.Data[1]	0		Decimal	INT
PM3K_CNT:I.Data[2]	0		Decimal	INT
PM3K_CNT:I.Data[3]	0		Decimal	INT
PM3K_CNT:I.Data[4]	0		Decimal	INT
PM3K_CNT:I.Data[5]	0		Decimal	INT
PM3K_CNT:O	{...}	{...}		AB:CONTROLNE...
PM3K_CNT:C	{...}	{...}		AB:CONTROLNE...

Download the revised program to the controller. Run RSNetworx for ControlNet to schedule the connection between the controller and the Powermonitor 3000. Refer to the RSNetworx for ControlNet documentation for assistance.

The ControlNet Powermonitor 3000 supports up to 64 concurrent Class 1 connections to instance 1 and one concurrent connection to instance 2.

Communicating to a Powermonitor 3000 from an SLC through 1747-KFC15 ControlNet

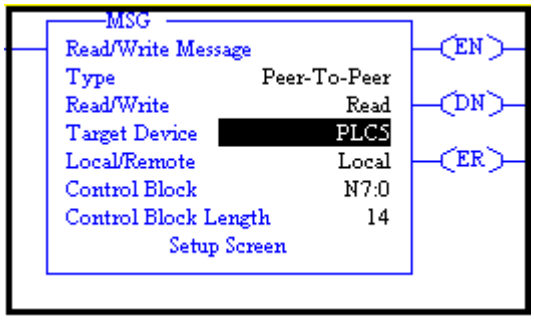
Connect the 1747-KFC15 according to your instruction manual documentation. There should be a connection from KFC15 RS232 port to Channel 0 of the SLC. For this example the communications and configuration of the channel 0 and the KFC15 were the following:

- KFC15 – DF1 station address "7"
- KFC15 and SLC baud rate at "19200"
- KFC15 and SLC" Full duplex"
- KFC15 and SLC Parity "None"
- KFC15 and SLC Handshaking "None"
- KFC15 Diagnostic Command Execution "Disabled"
- KFC15 Duplicate detect "Off"
- KFC15 and SLC Error Detect "CRC"
- KFC15 Number of Retries "3"
- KFC15 DF1 ACK Time Out "3.2"

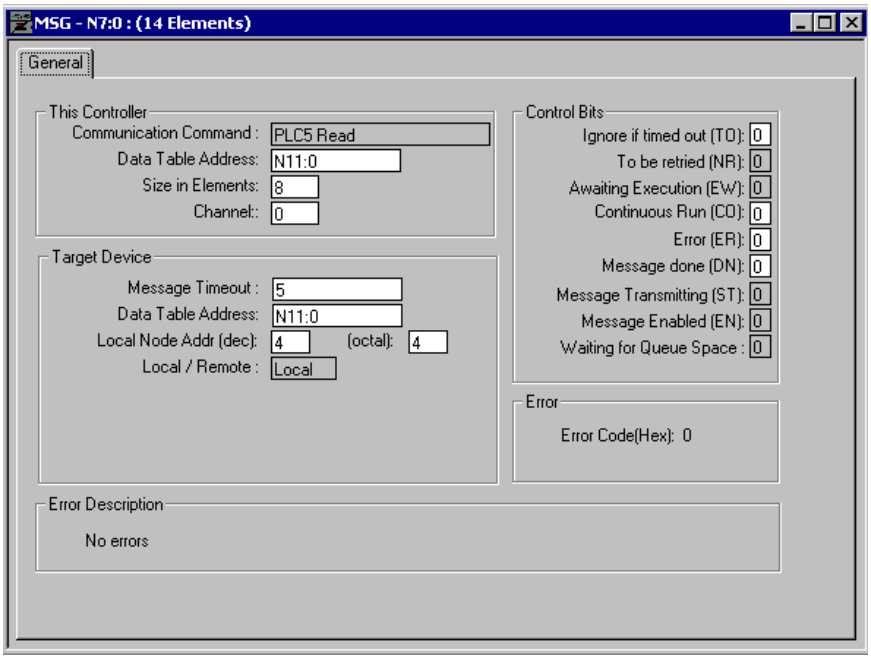
TIP Since it is easier to configure and much faster to run, full-duplex mode is the preferred mode of operation. Use half-duplex mode only if you do not have a choice.

Reading files from the Powermonitor 3000

Both integer and float files can be read from the Powermonitor 3000. This example reads the Date and Time table. Floats can be read by using this same process but destination file should be of type float.

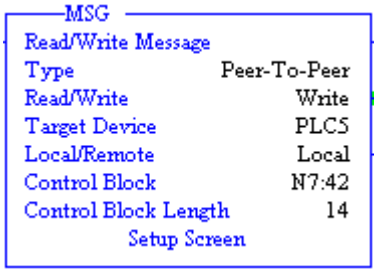


Select PLC5 for your Target Device, Local Network and Control Block. Fill out the “Setup Screen” as follows:

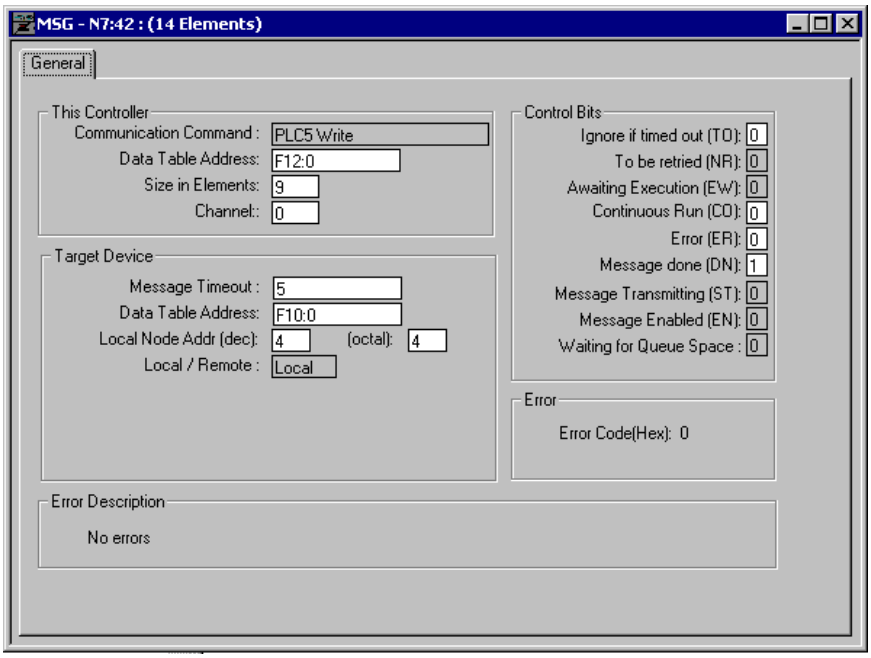


Notice that under target device that Powermonitor 3000 data table N11 (Date and Time) was selected. The Local Node Address is the address of the Powermonitor 3000 Controlnet Node Address “4”.

Writing data to the Powermonitor 3000 is done with the same method. It is recommended that 1 integer file and 1 float file be set aside in the SLC for use when writing to the Powermonitor 3000. Data to be written to the Powermonitor 3000 is loaded in one of these files according to data type before the transaction is started. The following example writes data to the Powermonitor 3000:



Select PLC5 for your Target Device, Local Network and Control Block. Fill out the “Setup Screen” as follows:



Notice that under target device that Powermonitor 3000 data table F10 (Basic Configuration) was selected. The Local Node Address is the address of the Powermonitor 3000 Controlnet Node Address “4”. The information to write was loaded into file F12:0 of the SLC and is 9 elements long.

Communicating to a Powermonitor 3000 from a PLC5 Controlnet Processor

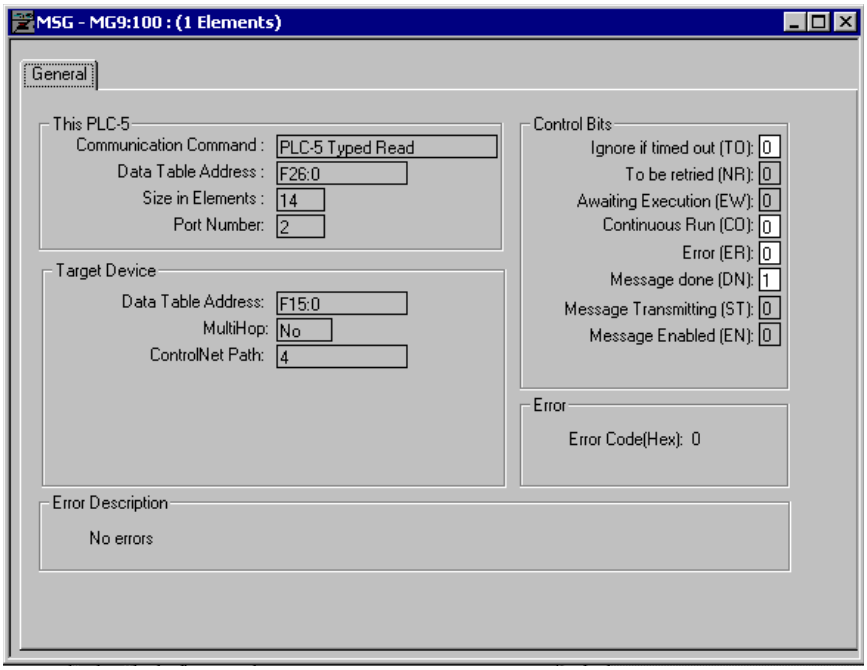
The Powermonitor 30000 is capable of communicating over controlnet using PLC5 typed reads and writes. When using ladder to communicate unscheduled messages to and from the Powermonitor 3000 the following example applies.

PLC5 Typed Reads and Writes

You can message integer and float files to and from the Powermonitor 3000 using PLC5 typed message instructions as follows:

Insert a MSG Instruction to the ladder rung and assign a control.

This example reads the Voltage, Current and Frequency table, File F15 from the Powermonitor 3000

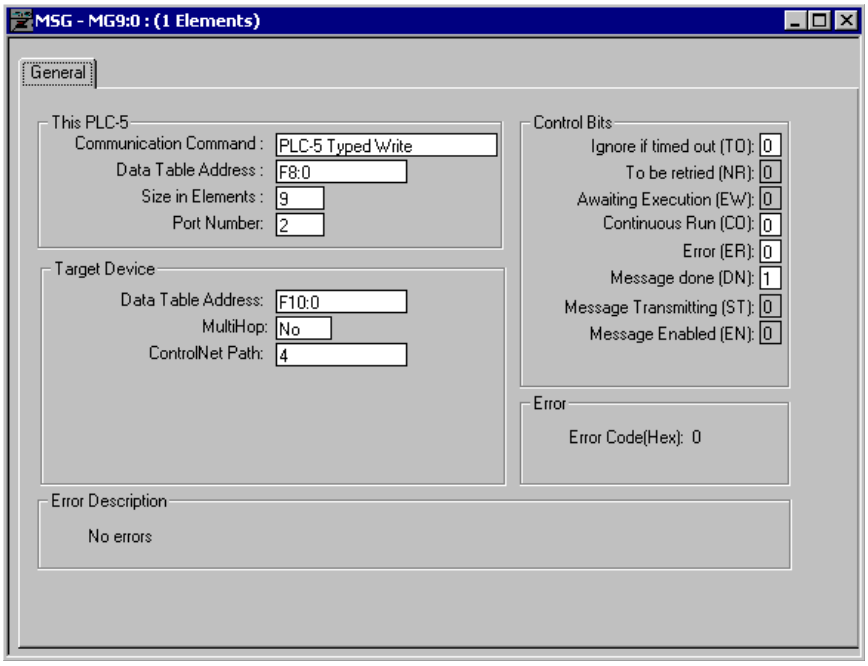


Notice that when using an unscheduled message directly to the Powermonitor 3000, in this case node 4, that the message format is local, multi-hop selection is no.

The following selection performs a write operation to the basic configuration table F10 of the Powermonitor 3000.

Insert a MSG Instruction to the ladder rung and assign a control.

This example writes configuration to the Basic Configuration table, File F10 in the Powermonitor 3000.



This message transfers 9 floats from table F8:0 to the Powermonitor 3000 table F10. The Powermonitor 3000 address is at node 4, local message.

How to Clear or Preset Energy Counters Using Communications

You may clear or preset the energy counters by performing a table write to Table A.14 Metering Real and Apparent Energy Results or Table A.15 Metering Reactive Energy and Amp-Hour Results. These read/write tables each contain 22 integer elements as follows:

- *Password:* required to clear or preset an energy counter, returns -1
- *Parameter select:* bitfield used to select parameter for clearing or presetting. See below
- *Energy counter values:* expressed in integer-array format, see page 4-18
- *Metering iteration:* increments by 1 with each new set of results, rolls to 0 at 32,767

The Parameter select bitfield value selects the parameter or parameters to be cleared or preset during the current write, as shown in the table below.

Table 4.12

Bitfield value		Parameter	
Binary	**Decimal**	**Table 14**	**Table 15**
000	0	-	-
001	1	kWh forward	kVARh forward
010	2	kWh reverse	kVARh reverse
100	4	kVAh	kAh
111	7	All	All

You may select the value at which the energy counters roll over to 0 in Table A.6 Advanced Device Configuration.

User-Configured Data Table

If your application requires monitoring a small number of parameters normally found in different data tables, and you need to conserve communications bandwidth, then the Powermonitor 3000 user-configured data table may be an ideal solution. To use this table, your data client application performs a write to Table A.30 User-Configured Table Setup, containing the desired parameters that you select from Table A.59 Parameters for Trend Log and Configurable Table. To read the user configured table, perform a table read of Table A.31 User-Configured Table Results.

The user-configured table setup includes the following elements:

- *Password*: needed to change the configuration
- *Table identifier*: a number that identifies the results table. For DF1 and Ethernet PCCC/CSP, this is file number 31; for EtherNet/IP, DeviceNet, and ControlNet, instance 37 or 1 (see User-configured I/O table below)
- *Parameter selections*: from Table A.59. The first zero ends the list of parameters

Table A.31 will return 14 elements (DeviceNet units) or 23 elements (all other communications options) containing the parameters you specified. You may specify more than 14 elements in DeviceNet units but it will return only 14. The results table data is in floating-point format. The first zero-valued element in the configuration write determines how many meaningful elements are returned in a read of the results table.

Refer to User-Configured Data Table Setup Using ControlLogix and EtherNet/IP on page C-27 for a sample ladder diagram and messages used to configure and read the user-configured data table.

User-Configured I/O Table

You may configure Input Messaging Instance 1 in Powermonitor 3000 units with optional DeviceNet, EtherNet/IP (Series B), or ControlNet communications in the same way as the user-configured data table above. You have one additional option for Instance 1: you may select the data type of Instance 1 as integer (0) or floating-point (1).

TIP Refer to the Rockwell Automation Knowledgebase (http://www.ab.com) for additional information on setting up a user-configured I/O instance.

Setpoint Programming and Operation

Setpoint operation provides a method other than communications for the Powermonitor 3000 to be used in and interact with power and energy applications. Some examples of setpoint applications include:

- Turning on an output relay when predicted demand exceeds a preset level, for simple demand management
- Turning off an output relay if phase rotation is accidentally reversed, helping to assure that loads rotate in the correct direction
- Capturing an oscillogram when a status input is energized

Theory of Setpoint Operation

Setpoint operation permits the Powermonitor 3000 to simultaneously monitor a number of parameters and take action when specified conditions are met. The M4 and M5 models support 10 setpoints while the M6 and M8 support 20.

There are eight parameters to configure for each setpoint: *Setpoint Number, Type, Evaluation Condition, High Limit, Low Limit, Action Delay, Release Delay,* and *Action Type*. These parameters are described in Table 5.1.

In the M6 and M8 models, setpoints 19 and 20 have special significance and are preset at the factory. Refer to Sag and Swell in the Advanced Features chapter of this manual.

When a setpoint activates, it takes the action defined in *Setpoint Action Type* and writes a time-stamped entry to the Event Log. Setpoint action types that energize a relay or KYZ output or set an alarm flag are maintained until the setpoint releases. Other setpoint actions such as capturing an oscillograph or clearing a counter occur when the setpoint activates. The Powermonitor 3000 also writes a time-stamped entry in the Event Log when the setpoint releases.

The event log record contains the maximum over-voltage or under-voltage recorded during a swell or sag condition, respectively. This applies only to models M6 and M8 beginning with master module firmware revision 2.5x. Prior to version 2.5x, the event log record includes the high and low limits of the setpoint.

TIP You should assign each setpoint a unique action type. If more than one setpoint are assigned an action type, unpredictable output action may result.

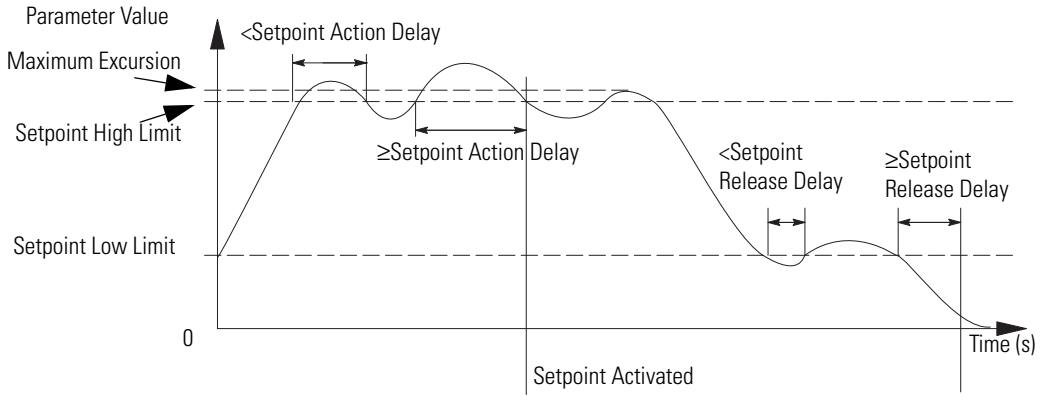
You may read setpoint output flags in Table A.3 Discrete Data and Table A.2 Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging. You may read only the first 8 setpoint output flags in the discrete input table with optional Remote I/O communications.

Setpoints evaluate data based on six different conditions: over forward, over reverse, under forward, under reverse, equal, and not equal. Over and under setpoint evaluation conditions may only be used with analog values such as voltages, currents, power, etc. Reverse setpoints are typically used to monitor power and energy when on-site generation is present. Equal and not equal evaluation conditions are for use with discrete conditions such as phase rotation, status inputs and transient detection.

Over Forward Setpoint

An *over forward* setpoint activates when the magnitude of the parameter being monitored (defined by the *Setpoint Type*) increases beyond the *Setpoint High Limit* and remains over the limit for a time greater than the *Setpoint Action Delay*. The setpoint releases when the magnitude of the parameter being monitored decreases below the *Setpoint Low Limit* and stays below the limit for a time greater than the *Setpoint Release Delay*.

Figure 5.1 Over Forward Setpoint Operation

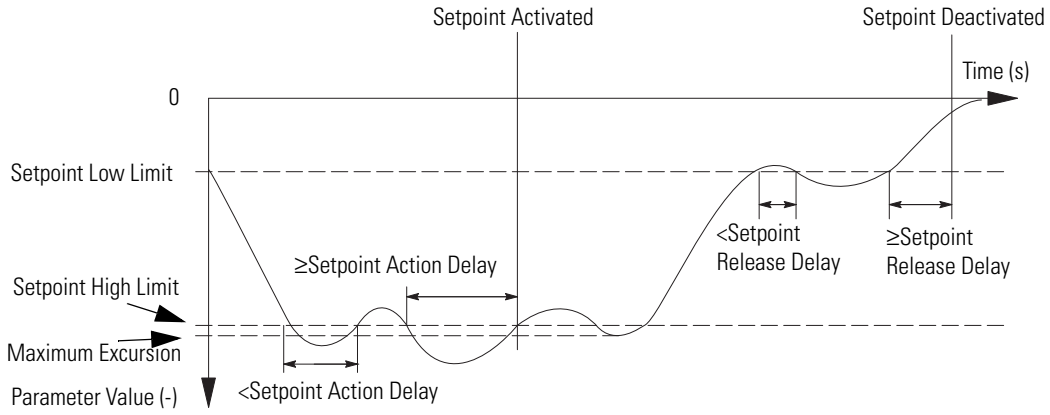


Over Reverse Setpoint

An *over reverse* setpoint is the mirror image of an over forward setpoint. For reverse setpoints, all the magnitudes and limits are negative.

An over reverse setpoint activates when the magnitude of the parameter being monitored (defined by the *Setpoint Type*) increases beyond the *Setpoint High Limit* in the negative direction and remains over the limit for a time greater than the *Setpoint Action Delay*. The setpoint releases when the magnitude of the parameter being monitored decreases below the *Setpoint Low Limit* and stays below the limit for a time greater than the *Setpoint Release Delay*.

Figure 5.2 Over Reverse Setpoint Operation

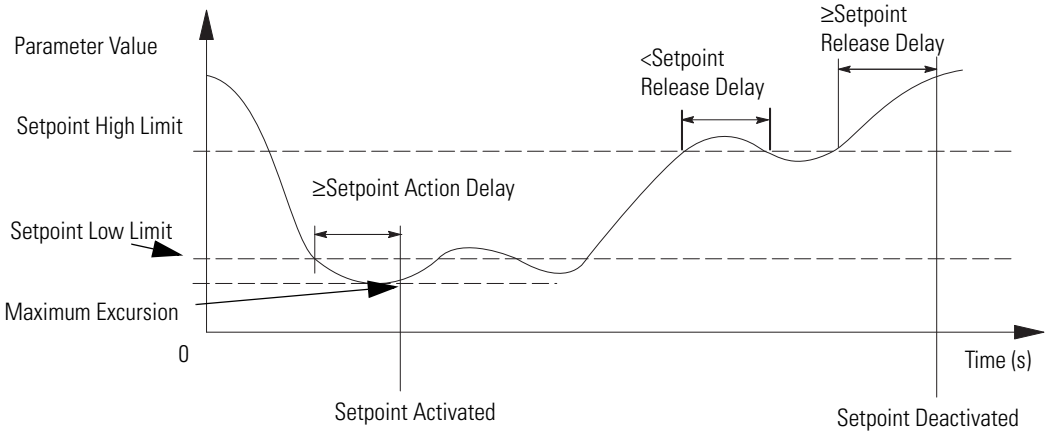


Under Forward Setpoint

An *under forward* setpoint is similar to an over forward setpoint, except the *Setpoint High Limit* and the *Setpoint Low Limit* are reversed.

An under forward setpoint activates when the magnitude of the parameter being monitored (defined by the *Setpoint Type*) decreases below the *Setpoint Low Limit* and remains below the limit for a time greater than the *Setpoint Action Delay*. The setpoint releases when the magnitude of the parameter being monitored increases above the *Setpoint High Limit* and stays above the limit for a time greater than the *Setpoint Release Delay*.

Figure 5.3 Under Forward Setpoint Operation

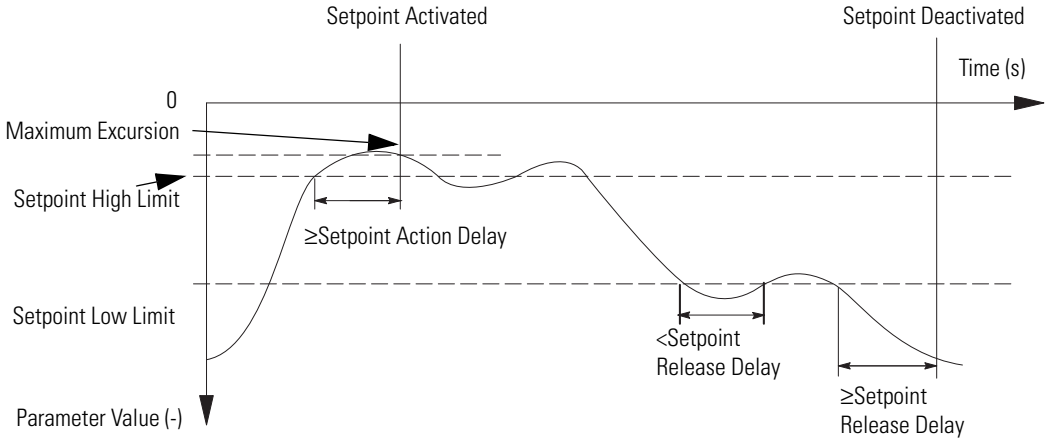


Under Reverse Setpoint

An *under reverse* setpoint is the mirror image of an under forward setpoint. The magnitude and all limits are negative numbers.

An under reverse setpoint activates when the magnitude of the parameter being monitored (defined by the *Setpoint Type*) decreases below the *Setpoint Low Limit* in the negative direction and remains below the limit for a time greater than the *Setpoint Action Delay*. The setpoint releases when the magnitude of the parameter being monitored increases above the *Setpoint High Limit* and stays above the limit for a time greater than the *Setpoint Release Delay*.

Figure 5.4 Under Reverse Setpoint Operation



Equal Setpoint

An *equal* setpoint activates when the monitored parameter equals the *Setpoint High Limit* for a time greater than the *Setpoint Action Delay*. An equal setpoint releases when the monitored parameter does not equal the *Setpoint High Limit* for a period of time greater than the *Setpoint Release Delay*. The *Setpoint Low Limit* is not used for equal and not equal setpoints.

Not Equal Setpoint

A *not equal* setpoint is the opposite of an equal setpoint, activating when monitored parameter does not equal the *Setpoint High Limit* for a time greater than the *Setpoint Action Delay*. It releases when the monitored parameter equals the *Setpoint High Limit* for a period of time greater than the *Setpoint Release Delay*.

Configuring Setpoints

You may configure setpoints using the Display Module or by writing the setpoint configuration table using communications. The following tables describe setpoint configuration parameters.

Table 5.1 Setpoint Configuration

Parameter Name	Parameter Description	Range	Units	Default
Setpoint Number	The number of the setpoint being configured.	1 to 10 (M4, M5) 1 to 20 (M6, M8)	-	N/A
Setpoint Type	The parameter value to be evaluated by the setpoint.	0 to 52 (Refer to Table A.19)	-	0
Setpoint Evaluation Condition	The operator used to evaluate the parameter value.	0 = Over forward (+) 1 = Over reverse (-) 2 = Under forward (+) 3 = Under reverse (-) 4 = Equal (=) 5 = Not equal (<>)	-	0
Setpoint High Limit	The value being used as a reference to activate the setpoint for over comparisons, or to deactivate the setpoint for under comparisons. Note: This parameter is non-numeric when viewed via the Display Module, and the Setpoint Type is Phase Rotation or Status input.	0 to 10,000,000	Depends on type	0

Table 5.1 Setpoint Configuration

Parameter Name	Parameter Description	Range	Units	Default
Setpoint Low Limit	The value being used as a reference to deactivate the setpoint for over comparisons, or to activate the setpoint for under comparisons.	0 to 10,000,000	Depends on type	0
Setpoint Action Delay	The minimum time in seconds that the setpoint limit must be exceeded continuously before the setpoint will trigger.	0 to 3600	Sec (M4, M5)	0
		0 to 30,000	0.1 Sec (M6, M8)	
Setpoint Release Delay	The minimum time in seconds that the setpoint limit must not be exceeded continuously before the setpoint releases.	0 to 3600	Sec (M4, M5)	0
		0 to 30,000	0.1 Sec (M6, M8)	
Setpoint Action Type	The action that occurs when the setpoint is triggered.	0 to 32 (see details in Table 5.3)		0
Clear Accumulated Time	Clear the time accumulator for this setpoint	Yes No		N/A

Table 5.2 Setpoint Types

Setpoint Type	Description	Units	M4, M5	M6	M8
0	Not used	-	•	•	•
1	Voltage[1]	Volts	•	•	•
2	Current[1]	Amps	•	•	•
3	Voltage unbalance	Percent	•	•	•
4	Current unbalance		•	•	•
5	Neutral current	Amps	•	•	•
6	W	Watts	•	•	•
7	VAR	VARs	•	•	•
8	VA	VA	•	•	•
9	Total true PF	Percent	•	•	•
10	Total disp PF		•	•	•
11	Total dist PF		•	•	•
12	W demand	Watts	•	•	•
13	VAR demand	VARs	•	•	•
14	VA demand	VA	•	•	•
15	Amp demand	Amps	•	•	•
16	Projected amp demand	Amps	•	•	•
17	Projected W Demand	Watts	•	•	•
18	Projected VAR Demand	VARs	•	•	•
19	Projected VA Demand	VA	•	•	•
20	Frequency	Hz	•	•	•
21	Phase rotation	-	•	•	•
22	Crest factor voltage	Volts	•	•	•
23	Crest factor current	Amps	•	•	•
24	Crest factor I4	Amps	•	•	•
25	IEEE THD voltage[1]	Volts	•	•	•
26	IEEE THD current[1]	Amps	•	•	•
27	IEEE THD I4	Amps	•	•	•
28	IEC THD voltage[1]	Volts	•	•	•
29	IEC THD current[1]	Amps	•	•	•
30	IEC THD I4	Amps	•	•	•
31	Status input 1	-	•	•	•
32	Status input 2		•	•	•
33	Any status input[1]		•	•	•

Table 5.2 Setpoint Types

Setpoint Type	Description	Units	M4, M5	M6	M8
34	Setpoint #1 time accumulator	Seconds	•	•	•
35	Setpoint #2 time accumulator		•	•	•
36	Setpoint #3 time accumulator		•	•	•
37	Setpoint #4 time accumulator		•	•	•
38	Setpoint #5 time accumulator		•	•	•
39	Setpoint #6 time accumulator		•	•	•
40	Setpoint #7 time accumulator		•	•	•
41	Setpoint #8 time accumulator		•	•	•
42	Setpoint #9 time accumulator		•	•	•
43	Setpoint #10 time accumulator		•	•	•
44	Voltage Sag(1) (2)	Volts		•	•
45	Voltage Swell(1) (2)			•	•
46	Transient detected(2)	-			•
47	Avg IEEE THD V	%	•	•	•
48	Avg IEEE THD I		•	•	•
49	Avg IEC THD V		•	•	•
50	Avg IEC THD I		•	•	•
51	Avg Crest Factor V	-	•	•	•
52	Avg Crest Factor I		•	•	•

(1) A setpoint activates when the magnitude of any phase passes the activation limit and releases when all phases pass the release limit in the appropriate direction for the setpoint evaluation condition.

(2) These setpoint types apply only to the applicable Powermonitor 3000 models and will appear as "inactive" on other models.

Table 5.3 Setpoint Action Type

Setpoint Action type	Description	M4 M5	M6	M8	Setpoint Action type	Description	M4 M5	M 6	M 8
0	None	•	•	•	22	Clear all energy results	•	•	•
1	Energize relay (and alarm flag 1)	•	•	•	23	Clear setpoint #1 time	•	•	•
2	Energize KYZ (and alarm flag 2)	•	•	•	24	Clear setpoint #2 time	•	•	•
3	Set alarm flag 3	•	•	•	25	Clear setpoint #3 time	•	•	•
4	Set alarm flag 4	•	•	•	26	Clear setpoint #4 time	•	•	•
5	Set alarm flag 5	•	•	•	27	Clear setpoint #5 time	•	•	•
6	Set alarm flag 6	•	•	•	28	Clear setpoint #6 time	•	•	•
7	Set alarm flag 7	•	•	•	29	Clear setpoint #7 time	•	•	•
8	Set alarm flag 8	•	•	•	30	Clear setpoint #8 time	•	•	•
9	Set alarm flag 9	•	•	•	31	Clear setpoint #9 time	•	•	•
10	Set alarm flag 10	•	•	•	32	Clear setpoint #10 time	•	•	•
11	Set alarm flag 11	•	•	•	33	Clear setpoint #11 time		•	•
12	Set alarm flag 12	•	•	•	34	Clear setpoint #12 time		•	•
13	Set alarm flag 13	•	•	•	35	Clear setpoint #13 time		•	•
14	Set alarm flag 14	•	•	•	36	Clear setpoint #14 time		•	•
15	Set alarm flag 15	•	•	•	37	Clear setpoint #15 time		•	•
16	Set alarm flag 16	•	•	•	38	Clear setpoint #16 time		•	•
17	Save a trend log record	•	•	•	39	Clear setpoint #17 time		•	•
18	Clear kWh result	•	•	•	40	Clear setpoint #18 time		•	•
19	Clear kVARh result	•	•	•	41	Clear setpoint #19 time		•	•
20	Clear kVAh result	•	•	•	42	Clear setpoint #20 time		•	•
21	Clear Ah result	•	•	•	43	Capture oscillograph		•	•

Examples of Setpoint Operation

Let us look again at the setpoint applications mentioned at the beginning of this chapter.

ATTENTION

These examples are intended to demonstrate setpoint configuration only. They should not be used as sample application programming references. Carefully consider all control, operational and safety issues when designing and implementing setpoint operations.

Example 1 – Simple demand management: To configure setpoint 1 to energize output relay 1 when projected demand exceeds 100 kW for more than one second and de-energize relay 1 when projected demand falls below 90 kW for more than two seconds, you could use the following settings.

Setpoint number	1
Setpoint type	17 - Projected Watt Demand
Setpoint evaluation condition	0 - Over forward
Setpoint high limit	100,000 watts
Setpoint low limit	90,000 watts
Setpoint action delay	1 second (M4, M5) 10 tenths of a second (M6, M8)
Setpoint release delay	2 seconds (M4, M5) 20 tenths of a second (M6, M8)
Setpoint action type	1 - Energize relay 1 and set alarm flag 1

Example 2 – Phase reversal relay: To use setpoint 2 to energize the output relay as a permissive for starting a three-phase motor, you could use the following settings.

Setpoint number	2
Setpoint type	21 - Phase rotation
Setpoint evaluation condition	4 - Equal
Setpoint high limit	1 - ABC
Setpoint low limit	Not used
Setpoint action delay	0 second (M4, M5) 0 tenths of a second (M6, M8)
Setpoint release delay	0 seconds (M4, M5) 0 tenths of a second (M6, M8)
Setpoint action type	1 - Energize relay 1 and set alarm flag 1

Example 3 – Oscillogram capture on demand: To use setpoint 3 to capture an oscillogram when you push a button connected to status input number 2, you could use these settings.

Setpoint number	3
Setpoint type	32 - Status input No. 2
Setpoint evaluation condition	4 - Equal
Setpoint high limit	1 - On
Setpoint low limit	Not used
Setpoint action delay	N/A (M4, M5) 5 tenths of a second (M6, M8)
Setpoint release delay	N/A (M4, M5) 5 tenths of a second (M6, M8)
Setpoint action type	43 - Capture oscillogram

Configuring Setpoints Using the Display Module

You may configure setpoint operations by navigating through the ***PROG*** > ***PASS?*** > ***CONFIGURATION*** > ***SETPOINT*** menus, selecting a setpoint number and programming the appropriate parameters.

Viewing Setpoint Data Using the Display Module

You may view setpoint setup parameters and status by navigating through these menus: ***DISP*** > ***CONFIGURATION*** > ***SETPOINT***, selecting the setpoint number and scrolling through the setpoint setup parameters, status and accumulated activated time.

Writing Setpoint Configuration Using Communications

To configure setpoint operations using communications, the client performs a table write to Table A.18 Setpoint Setup/Read-Back Select and Status. This read/write data table of 16 integer elements includes the following:

- *Password:* A valid password is required to enable, disable or clear the min/max log. Write a value of –1 when simply selecting a setpoint
- *Setpoint number:* Selects a setpoint for configuration or read-back; or indicates the currently selected setpoint on a read.
- *Read-back mode*: 0 selects auto-increment; 1 selects manual-increment (only mode supported by DeviceNet and Ethernet units)
- *Setpoint type:* Refer to Table 5.2
- *Evaluation condition:* 0 = Over forward; 1 = over reverse; 2 = under forward; 3 = under reverse; 4 = equal, 5 = not equal (see above)
- *High and low limits:* Expressed in integer/exponent format
- *Action and release delays:* Expressed in seconds (M4, M5) or tenths of a second (M6, M8)
- *Output action:* Refer to Table 5.3
- *Status:* 0 indicates released; 1 indicates activated; this read-only element is ignored on a write
- *Accumulated time:* Expressed in integer/exponent format
- *Clear time accumulator command:* 0 performs no action; 1 clears the accumulated time for selected setpoint

Reading Setpoint Status Data Using Communications

To read the setpoint status using communications, the client uses the indexed read method. The Powermonitor 3000 uses Table A.18 Setpoint Setup/Read-Back Select and Status both to select the setpoint to be read on the next read, and to return the status of the selected setpoint. In auto-increment mode (0), the first read returns the status of setpoint 1, the second read setpoint 2, and so on. In manual mode (1) the client alternates writes selecting the desired setpoint with reads of the setpoint status. See the list just above for the content of this data table.

I/O Operations

The Powermonitor 3000 is equipped with two relay outputs and two status inputs designed to provide a discrete interface with your application.

Relay and KYZ Output Operations

The Relay output is an electromechanical Form C relay with contacts rated at 10 amperes at 240 VAC or 250 VDC. This set of contacts is also rated to meet IEEE C37.90 requirements for power circuit breaker tripping duty. The KYZ output is a solid-state relay rated at 80 mA at 240 VAC or 250 VDC that provides higher reliability and long life for low-power signaling duty such as a kWh pulse output.

The two outputs operate independently and you may configure each output's operation individually. You may use the Display Module or communications to set the output configuration parameters in the Advanced Device Configuration table. The output configuration options for the relay and KYZ outputs include:

- *Control source:* specifies what controls the selected output. Options are 0= none; 1 through 6= pulsed output; 7= setpoint control; 8 discrete I/O control. Default = 7
- *Output scale:* specifies the scaling factor for pulsed operation. Range 1 to 30,000; default = 10
- *Output width:* specifies the pulse width for pulsed operation. Range 0 or 40 to 2,000 mSec
- *Force command:* overrides setpoint, communications, discrete or pulsed control until the force is released. Options are: 0 = no change; 1 = force the output energized; 2 = forced the output de-energized; 3 = release the force
- *Default output state on communications loss:* specifies response to a loss of communications. Options are 0= last state/ resume; 1= last state/ freeze; 2= de-energize/ resume; 3= de-energize/ freeze. See below.

Pulsed Control

Many electric energy meters provide a dry contact output that changes state at intervals determined by a metered parameter. *Pulsed control* lets the Powermonitor 3000 emulate this function. You may select the following options for the *Control source* parameter:

1 = Watt-hours forward
2 = Watt-hours reverse
3 = VAR-hours forward
4 = VAR-hours reverse
5 = VA-hours
6 = Ampere-hours

Set the *Output width* to the desired pulse duration in milliseconds. Set this parameter to zero (0) if you want the output to toggle instead of pulse. This operation emulates the KYZ operation of electromechanical energy meters. For a two-wire KYZ connection, use only one side of the relay. For a three-wire KYZ connection, use both sides of the Form C output.

In a two-wire interface, (KY connection), an output event occurs only when the output contact closes. In a three-wire connection, an event occurs when either the KY or KZ contact closes. Therefore twice as many output events occur in a three-wire connection as in a two-wire connection for the same number of relay transitions.

Set the *Output scale* for the number of increments of the *Control source* parameter it takes to pulse or toggle the selected output. Follow these suggested steps to calculate the *output scale*:

1. Determine the maximum value of the selected parameter expected in an hour period. This is related to the feeder capacity. For example, a 480 volt, 1200-ampere three-phase feeder can supply approximately 100 kW or 100 kWh per hour.

2. Divide this maximum parameter value by 3,600 to determine the maximum value expected per second. In our example, we round this to 280 Wh per second.

3. Select a maximum pulse rate. This should be between 2 and 5 pulses per second for a two-wire KYZ connection and between 2 and 10 pulses per second for a three-wire connection. Let's use a three-wire KYZ connection and a pulse rate of 4 pps.

4. Compute the output scale by dividing the result of (2) by the result of (3) and rounding to the nearest integer. For our example, we'll set the output scale to 70.

Setpoint Control

Set the *Control source* to a value of 7 to enable setpoints to control the selected output.

Discrete I/O Control

Set the *Control Source* to a value of 8 to enable Ethernet Series B, ControlNet, DeviceNet, or Remote I/O to have exclusive control over the Powermonitor 3000 output via I/O messaging.

Forced Operation

You may over-ride automatic output control by issuing a force command using the Display Module or by writing the appropriate force command parameter in the Advanced Device Configuration table. Forces override all other output control sources. If you force an output either energized or de-energized, be sure to release the force to re-establish your selected control source.

TIP If you cycle power to the Powermonitor 3000, all output forces are released.

No Control Operation

You may also select no output control by selecting a value of zero (0) for the Control source parameter. This mode enables only output forcing.

Communications Loss Behavior

IMPORTANT The relay output contacts and solid-state KYZ output contacts on the Powermonitor 3000 may be used to control other devices through setpoint control or communications, The response of these outputs to a communications failure is configurable by the user. Be sure to evaluate the safety impact of the output configuration on your plant or process.

The *Default output state on communications loss* defines the behavior of the output if the Powermonitor 3000 experiences a loss of communications. What constitutes a communications loss depends on the protocol. A Remote I/O unit declares a communications loss if it has detected more than 100 mSec between valid frames or more than 255 consecutive valid frames not addressed to it. A DeviceNet unit declares a communications loss when the network master (scanner) has not polled it within the Expected Packet Rate that you configured when setting up the I/O connection.

You may select one of the following behaviors for each output:

- *Last-state / resume*: holds the output in its last state during a communications loss and resume the output control when communication recovers.
- *Last-state / freeze:* holds the output in its last state during a communications loss and freezes the output in this state when communication recovers. You may clear the freeze by placing the logic controller into program mode, changing the behavior to last state / resume, or cycling power to the Powermonitor 3000.
- *De-energize / resume*: de-energizes the output during communications loss and resume output control when communication recovers.
- *De-energize / freeze:* de-energizes the output during communications loss and freezes the output de-energized when communication recovers. You may clear the freeze by placing the logic controller into program mode, changing the behavior to last state / resume, or cycling power to the Powermonitor 3000.

Status Input Operations

The Powermonitor 3000's two self-powered status inputs provide a number of flexible configuration options that help customize the Powermonitor 3000 operation to meet the requirements of your specific application.

Counters

You may use the Powermonitor 3000 to monitor discrete events such as circuit breaker status or kWh pulses from a legacy electrical energy, steam, gas or other type of meter. Each status input has associated with it an independent counter, which increments with every false-to-true transition of its input. The counter rolls over to 0 when it reaches its maximum value of 29,999. The counter value may be read using the Display Module or communications to provide a value proportional to the accumulated value of the meter connected to the status input. You may select the input counter values as Trend Log parameters.

You may clear either or both status input counters using the Display Module or by writing the appropriate command to the Advanced Device Configuration table.

Demand Period Synchronization

You may synchronize the Powermonitor 3000 demand period with a utility end-of-interval (EOI) pulse by wiring a dry contact controlled by the EOI pulse into Status Input 2 and setting the appropriate demand configuration parameters. Refer to Chapter 3 for more information about demand.

Setpoint Inputs

You may use one or both status inputs to activate setpoint control. Use an equal or not equal setpoint evaluation condition with status inputs.

Event Logging of Status Inputs

You may choose whether or not to record status input transitions in the Event Log. If you were using a status input to read a KYZ meter pulse, for example, recording transitions into the Event Log would quickly fill the log and overwrite potentially important event information. On the other hand, you may use the status input to detect a discrete condition that you want logged. Refer to Event Log Configuration Options on page 7-2.

Data Logging

Its inherent data logging capability makes the Powermonitor 3000 a versatile component in a number of power and energy applications. Cost allocation applications can read billing variables like energy usage and demand from the configurable Trend Log, making the accuracy of reports less dependent on a continuous network connection. The Event Log captures time-stamped records of important power system occurrences that can be aligned with corresponding production or environmental effects to better understand and optimize your energy use and costs. This chapter describes in detail the data logging functions in the Powermonitor 3000.

Event Log

The Event Log contains records stored in nonvolatile memory of the 50 (M4 and M5) or 100 (M6 and M8) most recent events that occurred in the Powermonitor 3000. Event records may include:

- Changes in the unit configuration
- Setpoint activation and release
- Relay or KYZ output forcing
- Status input change of state
- Power-up and power-down
- Clearing or presetting of an energy counter
- Setting the unit time and date
- Clearing of the trend or min/max log
- Clearing of setpoint timers
- Detection of a sag, swell or transient

Event Log Configuration Options

There are two options in the Event Log setup.

- You may choose to log or ignore (*ignore* is default) status input change-of-state. You may make this configuration setting using the Display Module by navigating through these menus: ***PROG*** > ***PASS****?* > ***CONFIGURATION*** > ***EVENT LOG*** and setting the *Log Status Inputs* parameter from *No* to *Yes*. You may also make this selection using communications.
- You may choose to log or ignore (*log* is default) changes to the date and time setting. You may make this selection only using communications.

These choices provide you with the flexibility to ignore routine occurrences, thereby increasing the time that important events are stored. For example, a status input may count pulses from a water or gas meter. Or, the unit may be connected to an energy logging system such as RSEnergyMetrix that synchronizes the time every night at midnight. In either case, important events would likely be overwritten by routine, nuisance events.

Viewing the Event Log Using the Display Module

You may view the entries in the Event Log by navigating through ***DISP****.* > ***LOGS*** > ***EVENT LOG***. The event number shows up in the top line, and in the bottom line an event description followed by the event time stamp scrolls across the display. Table 7.1 lists the event codes as shown on the Display Module.

Table 7.1 Event Codes

Event Type Name	Event Type Shown by DM	Event Type Number	Event Command Code
No Event	No Evnt	0	0
Setpoint Activated	Set##A(1)	1	Setpoint Number (1-10)
Setpoint Deactivated	Set##D(1)	2	Setpoint Number (1-10)
Relay Forced Energized	Rly# F1(1)	3	Relay Number (1-2)
Relay Forced De-energized	Rly# F0(1)	4	Relay Number (1-2)
Relay No Force Option	Rly# NF(1)	5	Relay Number (1-2)
Status Input Set	S# On(1)	6	Status Input Number(1-2)

Table 7.1 Event Codes

Event Type Name	Event Type Shown by DM	Event Type Number	Event Command Code
Status Input Cleared	S# Off(1)	7	Status Input Number(1-2)
kWh Counter Set	Wh Set	8	1
kVARh Counter Set	Varh Set	8	2
kVAh Counter Set	kVAh Set	8	3
Ah Counter Set	kAh Set	8	4
All Energy Counters Set	All Power Set	8	5
Trend Log Clear	Trend Clr	8	6
Min/Max Log Set	M/M Clr	8	7
Factory Defaults Restored	FactCfg	8	8
Status Input Counter 1 Cleared	S1 Clr	8	9
Status Input Counter 2 Cleared	S2 Clr	8	10
Reserved for Future Enhancement			11
Single Setpoint Timer Clear	Single SP Set		12
All Setpoint Timers Clear	All SP Set		13
Power Up	Pwr On	9	0
Power Down	Pwr Off	10	0
Self-test Error	ST ####(1)	11	Hexadecimal Status Error Code (See Table 7.2)
Time Set	TimeSet	12	0
Device Reconfigured	New Cfg	13	0
Setpoint Reconfigured	Set Cfg	14	0
NVRAM Set	NVRAM Set	15	0
Transient Detected	TRN Det	16	M8 only
User Text	-	17	M8 only

(1) Number indicates a numeric digit.

Table 7.2 Status Error Codes

Bits	Hex	Description
bit 0	0001h	Master Module code flash status
bit 1	0002h	Master Module data flash status
bit 2	0004h	Master Module RAM Status
bit 3	0008h	Reserved for factory use
bit 4	0010h	Master Module NVRAM status
bit 5	0020h	Master Module data acquisition status
bit 6	0040h	Master Module real time clock status
bit 7	0080h	Reserved for factory use
bit 8	0100h	Reserved for factory use
bit 9	0200h	Display Module status
bit 10	0400h	Master Module watchdog timer status
bit 11	0800h	Master Module optional communications status
bit 12-15	1000h -8000h	Reserved for factory use

Configuring the Event Log Using Communications

You may configure the Event Log by performing a valid table write to Table A.26 Event Log Configuration/Read-Back Record Select. This read/write data table contains these 6 integer elements:

- *Password:* A valid password is required to set configuration options or -1 to select a record for read-back
- *DeviceNet unique write identifier*
- *Read-back mode:* see below
- *Status input logging:* 0 disables; 1 enables
- *Number of events logged:* this read-only element is ignored on a write
- *Time/date set logging:* 0 disables; 1 enables

Reading Data from the Event Log Using Communications

The Event Log uses the indexed read method. Table A.26 is the *Read-back Select* table and Table A.27 is the *Results* table. You may select among a number of read-back options for the Event Log:

0 = Auto-increment / start at beginning of log

1 = Auto-increment / start at end of log

2 = Auto-decrement / start at end of log

3 = Point to the beginning of log

4 = Point to the end of log

5 = Index to the next record

6 = Index to the previous record

Indexing occurs after each read of the *Results* table.
Only mode 0, 1 and 2 are supported by DF1 and Remote I/O communications.

Table A.27 is a read-only data table containing 14 (M4, M5), 17 (M6) or 18 (M8 only) integer elements as follows:

- *Reserved:* returns 0
- *Event record internal identifier:* An incremental number assigned to each new event. See below
- *Timestamp:* event timestamp expressed in four-element timestamp format (see below)
- *Event type:* see Table 7.1
- *Event command code:* see Table 7.1 and Table 7.2
- *Setpoint type, evaluation condition, level, action/release delay, and action:* if event is a setpoint, these elements return additional information about the setpoint. The *Setpoint level*, expressed in integer/exponent format, records the worst-case value of the setpoint parameter
- *Sustain limit timer (M6, M8 only):* time the setpoint parameter exceeded the limit, expressed in integer/exponent format
- *Capture identifier (M6, M8 only):* identifies oscillograph or transient capture number if applicable
- *Event text available (M8 only):* 0 indicates no user comment; 1 indicates a user comment has been stored in the current record (see below)

For the M8 model, you may use the *Event record internal identifier* and the *Event text available* flag for reading and writing user comments. Please refer to the section immediately below.

TIP

The Powermonitor 3000 expresses timestamps in an array of four data table elements:

Year
Month/day
Hour/minute
Second/hundredth of a second

Each timestamp parameter (except the *Year*) is a combination of its first and second element. For instance, the *Month* = the parameter value divided by 100 with the remainder = the *Day*.

Example: 1230 = December 30th.

Event Log User Comment Field (M8 only)

The 1404-M8 lets you enter a user comment up to 50 characters in length into the Event Log, allowing you to record the impact of an event on your plant or process. You may add a user comment to an existing event or create a new time-stamped event to contain a user comment. Once they are first written, user comments are read-only.

The Display Module does not support entry or viewing of User Comments.

Writing a User Comment using communications

Table A.50 Event Log Text is the interface to the user comment function. Each read or write of the data table returns or writes 26 characters, so it takes two reads or writes to address the entire 50-character user comment.

This read/write table contains 22 integer elements including the following:

- *Password:* A valid password is required to write a user comment; write a value of -1 to select a record for read-back
- *Write type:* 0 selects a record for readback; 1 selects a record for writing a new user comment (prevents inadvertent creation of a user comment)
- DeviceNet unique write identifier
- *Text block number:* 1 for the first 26, or 2 for the last 24 characters in the user comment string
- *Event record internal identifier:* -1 creates a new event; 0 - 32767 selects the corresponding event record to write; see below
- Timestamp of user-entered event
- *Text character pair data:* see below

The *Event record internal identifier* value between 0 and 32767 selects the corresponding existing event. A read of Table A.27 returns the *Event log internal identifier* in element 1 and the *Event text available* flag in element 17.

Each *Text character pair* element in the table contains two characters expressed in ASCII standard coding. On a write, *Text character pair data* will be written into the specified *Block number* for the event record unless a user comment already exists for the selected record.

You may calculate the position of the characters in the user comment as follows:

$$((\text{Text Block \#} - 1) \bullet 26) + (\text{Text Character Pair \#})$$

Example: the value 3345 hex in character pair #2, block #2, corresponds to “3” and “E” in character positions 28 and 29 in the user comment string.

Reading a User Comment using communications

You read a User Comment using a variation of the indexed read method. Typically, a client reads the Event Log and, when it finds the *Event text available* flag set in the results table, runs a routine to read the user comment. Two writes to, and two reads of Table A.50 Event Log Text are needed to read the entire user comment. The first write contains these elements:

- *Password:* -1
- *Write type:* 0
- *DeviceNet unique write identifier:* as applicable
- *Text block #:* 1
- *Event record internal identifier:* from Table A.27, element 1; selects record to read

The remaining records may remain 0.

The next read of Table A.50 returns the first 26 characters in the user comment. The next write is identical except the *Text block #* must be 2. The next read returns the last 24 characters in the user comment.

Configurable Trend Log

You can learn a great deal about, and learn how to reduce, your enterprise's energy costs by keeping a historical record of power and energy usage. The *Configurable Trend Log* allows you to set up automatic logging of up to 16 parameters at intervals between 1 second and 1 hour. It can store over 45,000 individual records in nonvolatile memory.

You must use communications to configure and read the Trend Log. There is no Display Module interface for either configuration or monitoring.

Trend Log Modes of Operation

The Trend Log operates in one of two modes:

- *Fill and Hold* - record logging continues until the log is full. The user must clear the log for logging to continue.
- *Overwrite* - logging operates in first-in, first-out mode whereby each new record overwrites the oldest record. The trend log always contains the most recent records.

Default configuration:

As shipped from the factory, a Powermonitor 3000 will log net kilowatt-hours (kWh), net kVAR-hours (kVarh) and demand watts, at 15-minute intervals, in overwrite mode.

TIP If you use the Powermonitor 3000 with an energy logging software such as RSEnergyMetrix, you should coordinate the parameters selected for the Trend Log with those logged by the software. This allows for the energy logging software to poll the Trend Log data, allowing for less frequent polling and automatic data repopulation of the energy database.

Calculating Trend Log Depth

How long the Trend Log takes to fill may be as little as 90 minutes or as long as 5 years depending on how you configure the log. These formulas will help you configure the trend log to obtain the results you want. Round off any results to the next lower integer.

Trend Log Depth Formula

This formula returns the number of records in the trend log for the number of parameters logged. To determine the length of time this represents, multiply the result by the trend log interval.

$$D = \frac{(7 - F) \bullet 65524}{(P \bullet 4) + 6}$$

Where:

D = Depth of the trend log in records
F = Fill mode (0 = fill and hold, 1 = overwrite)
P = Parameters per record (1 - 16)

Parameters per Record formula

If your application requires a certain number of records or time to preserve logged information, this formula returns the number of parameters per record allowed.

$$P = \frac{(7 - F) \bullet 16381}{D} - 1.5$$

Examples

Example 1: A user wants to log kW every 15 minutes and wants to know how many records the log will contain and how long a time that will cover. The first formula applies:

$$D = \frac{(7 - 0) \bullet 65524}{(1 \bullet 4) + 6}$$

Fill and hold mode allows logging the most records. Logging only 1 parameter per record, the formula results in a total of 45,866 records after rounding down. Logging every 15 minutes, this log configuration will log 15.8 months of kW data.

Example 2: Another user wants to log several parameters every 5 minutes indefinitely, retrieving the records within one week after the end of each month. He will save the retrieved data and create trend graphs on his PC. The question is how many parameters may be monitored. The second formula applies to this example:

$$P = \frac{(7 - 1) \bullet 16381}{10944} - 1.5$$

The total log depth of 10,944 is based on the log duration and interval: (31 days per month + 7 days) * (24 hours per day) * (60 minutes per hour) / 5 minute logging interval. Overwrite mode (F = 1) allows you to read the log any time without losing any data.

In this example, P, the number of parameters that may be recorded, is 7, rounded down from 7.48.

From this example, you can see that the trend log can log 7 parameters every 5 minutes in a 38-day sliding window.

Setting up the Trend Log

You configure the Trend Log by performing a table write to Table A.21 with the desired configuration settings. This read/write data table contains 26 integer elements including:

- *Password*: Required to configure logging, you may use -1 for read-back selection
- DeviceNet unique write identifier
- *Read-back mode*: See below; must be a valid entry even if read-back is not being selected at this time
- *Logging interval*: Interval in seconds (1 to 3,600). 0 disables logging but does not disable setpoint-triggered logging; -1 synchronizes logging with demand interval.
- *Logging mode*: 0 selects overwrite mode; 1 selects fill and hold.
- *Clear log command*: 0 takes no action; 1 clears the trend log.
- *Parameter selections*: You may select up to 16 parameters from the list in Table A.59 to be logged. An entry of 0 selects no parameter; only parameters preceding the first 0 in the table will be logged.
- *Reserved elements*: Must be 0
- *Total records logged*: These read-only elements are ignored during a write

TIP Although you may configure up to 16 Trend Log parameters on units with optional DeviceNet communications, the results table will return only the first 8.

The Powermonitor 3000 clears the trend log when you change any parameter or the logging interval.

You may perform a simple table read of Table A.21 to view the existing Trend Log configuration. When you read this table, the password element returns a value of -1 and the reserved and command elements return a value of 0. Elements 7 and 8 return the *Total Records Logged* * 1000 and * 1 respectively.

Reading Data from the Trend Log

To read the Trend Log, use the indexed read method. A write to Table A.21 selects which trend log record is read next. There are a number of auto-increment and manual-increment options that may be selected by writing to the *Read-back Mode* element in Table A.21:

0. *Auto-increment / start at beginning:* Start at the oldest log record and index to the next record after each read of the results table

1. *Auto-increment / start at end:* Start at the newest log record and index to the next record after each read

2. *Auto-decrement / start at end:* Start at the newest log record and index to the previous record after each read

3. Point to the oldest log record

4. Point to the newest log record

5. Index to the next record after each read of the results table

6. Index to the previous record after each read

Only mode 0, 1 and 2 are supported by DF1 and Remote I/O communications. In modes 0, 1 and 2 the client need only read the results table repeatedly until the entire Trend Log is read. In modes 3 through 6 the client must alternate writes to select the next read-back record with reads of the results table. You may obtain the number of records in the Trend Log by reading Table A.21, elements 7 and 8. The number of records is (element 7) * 1000 + (element 8).

Only the following elements are needed during a record-selection write:

- *Password:* -1
- *DeviceNet unique write identifier:* as applicable
- *Reserved words:* must be 0
- *Read*-back mode: see above

Table A.22 Trend Log Results is a read-only table of 14 (DeviceNet) or 22 (all other communications options) floating-point elements as follows:

- *Reserved element:* returns 0
- *Internal identifier:* increments by 1 to 15 for each trend log record then rolls over to 0
- *Time stamp:* in 4-element timestamp format. See page 3-28.
- *User-selected parameters:* parameters you selected when you configured the Trend Log.

Min/Max Log

The *Min/max Log* maintains a time-stamped record of the minimum and maximum values of up to 74 metering parameters. You can monitor values over a day, a week, a month or any period to record the highest and lowest values of voltage, current, power factor, etc.

Most industrial utility bills include a charge based on the maximum demand recorded during the billing period. You could use the Min/max log to provide that piece of data for generating an internal or shadow billing report.

Accessing the Min/Max Log Using the Display Module

To view log entries, navigate through these menus: ***DISP.*** > ***LOGS*** > ***MIN/MAX LOG***. The first log record title will appear, ***M.M.LOG AMPS L1***. Press the *Enter* key and the record data will scroll across the display: ***MIN #.### MM/DD/YYYY hh|mm MAX #.### MM/DD/YYYY hh|mm***. Pressing any key will return to the record title display, then you may press the *Up Arrow* or *Down Arrow* keys to select the next record you wish to view. Refer to Table 7.3 for a complete list of Min/max log parameters.

Configuration: You may choose to enable or disable the Min/max log using the Display Module by navigating these menus: ***PROG.*** > ***PASS?*** > ***CONFIGURATION*** > ***MIN/MAX LOG***, and selecting ***ON*** or ***OFF*** using the arrow keys and the *Enter* key. You may also make this selection using communications.

Clearing the Log: You may clear the Min/max log using the Display Module by navigating these menus: ***PROG.*** > ***PASS?*** > ***COMMANDS*** > ***MIN/MAX LOG CLEAR***. Press the *Up Arrow* or *Down Arrow* key until ***Yes*** appears, then press the *Enter* key. You may also clear the Min/max Log using communications.

Interfacing with the Min/Max Log Using Communications

Write Min/max Log configuration settings and command using a table write to Table A.23 Min/Max Log Configuration/Read-Back Select.

Access data in the Min/max Log using the indexed read method. Write to Table A.23 to select the read-back mode and/or which of 74 min/max records to return on the next read of Table A.25 Min/Max Log Results.

Table A.23 contains 9 integer elements:

- *Password:* Required to enable, disable or clear the min/max log; -1 for selecting a record
- *Parameter to read:* The record number to read next, or the starting record for auto-increment *read-back mode*
- *Read-back mode:* 0 selects auto-increment mode; returns the next min/max record after each read of the *results* table, 1 selects manual indexed mode (only mode 0, 1 and 2 are supported by DF1 and Remote I/O communications)
- *Enable/disable Min/max Log:* 0 disables, 1 enables
- *Clear Min/max Log command:* 0 takes no action, 1 clears the log and writes a time stamp
- *Timestamp of last Min/max clear:* the last four elements store the last-clear timestamp (read-only; these elements ignored on a write)

Table 7.3 Min/Max Log Parameter Listing

Param. Number	Parameter Name	Param. Number	Parameter Name
0	L1 Current	37	Projected Demand I
1	L2 Current	38	Projected Demand W
2	L3 Current	39	Projected Demand VAR
3	Avg Current	40	Projected Demand VA
4	L1-N Voltage	41	L1 True Power Factor
5	L2-N Voltage	42	L2 True Power Factor
6	L3-N Voltage	43	L3 True Power Factor
7	Avg L-N Voltage	44	3-phase True PF
8	L1-L2 Voltage	45	L1 Displacement Power Factor
9	L2-L3 Voltage	46	L2 Displacement Power Factor
10	L3-L1 Voltage	47	L3 Displacement Power Factor
11	Avg L-L Voltage	48	3-phase Displacement PF
12	Frequency, last cycle	49	L1 Distortion Power Factor
13	L4 Current	50	L2 Distortion Power Factor
14	Positive Sequence Current	51	L3 Distortion Power Factor
15	Negative Sequence Current	52	3-phase Distortion PF
16	% Current unbalance	53	V1% IEEE THD
17	Positive Sequence Voltage	54	I1% IEEE THD
18	Negative Sequence Voltage	55	V2% IEEE THD
19	% Voltage unbalance	56	I2% IEEE THD
20	Average frequency	57	V3% IEEE THD
21	L1 Real Power	58	I3% IEEE THD
22	L2 Real Power	59	I4% IEEE THD
23	L3 Real Power	60	V1% IEC thd (DIN)
24	Total Real Power	61	I1% IEC thd (DIN)
25	L1 Reactive Power	62	V2% IEC thd (DIN)
26	L2 Reactive Power	63	I2% IEC thd (DIN)
27	L3 Reactive Power	64	V3% IEC thd (DIN)
28	Total Reactive Power	65	I3% IEC thd (DIN)
29	L1 Apparent Power	66	I4% IEC thd (DIN)
30	L2 Apparent Power	67	V1 Crest Factor
31	L3 Apparent Power	68	I1 Crest Factor
32	Total Apparent Power	69	V2 Crest Factor
33	Demand Current	70	I2 Crest Factor
34	Demand Power	71	V3 Crest Factor
35	Demand Reactive Power	72	I3 Crest Factor
36	Demand Apparent Power	73	I4 Crest Factor

Table A.25 Min/Max Log Results is a read-only data table consisting of 11 floating-point elements containing the following information:

- *Parameter #:* See Table 7.3 above
- *Min and max values*
- *Timestamps:* for Min and Max values in four-element timestamp format

Time-of-use

The Powermonitor 3000 provides a *Time-of-Use Log*. Also called the TOU log, it provides a one-year time-of-use history of energy usage and demand. The time-of-use log provides the following:

- User-selectable on-peak, mid-peak and off-peak hours
- User-selectable off-peak days of the week
- Real, reactive and apparent energy usage records
- Real, reactive and apparent power demand records
- Month-to-date record for the current month
- Monthly history for the past year
- User-selectable day of month to begin time-of-use logs

The time-of-use log is designed to support simple billing and cost allocation applications that apply different rates to energy and demand used at different times.

The Time-of-Use Log is available only in Powermonitor 3000 models with firmware revision 2.5x or later.

Time-of-Use hours selection

Off peak hours are those which occur on off peak days or during hours not selected as either mid peak or on peak. Hours selected as both mid peak and on peak will be evaluated as on peak hours.

RSEnergyMetrix selects the appropriate time-of-use logs to store energy and demand values based on the time-of-use hours selection and the off peak day selection.

Time-of-use selection elements are bit mapped parameters. The bits are mapped as shown in the table below, which depicts the default values as an example. The default time-of-use periods are:

- *Mid peak AM* – 8:00 to 10:59
- *Mid peak PM* – 3:00 to 6:59

- *Peak AM* – 10:00 – 11:59
- *Peal PM* – 12:00 noon – 2:59

TOU Period	AM												PM											
	12:00 – 12:59	1:00 – 1:59	2:00 – 2:59	3:00 – 3:59	4:00 – 4:59	5:00 – 5:59	6:00 – 6:59	7:00 – 7:59	8:00 – 8:59	9:00 – 9:59	10:00 – 10:59	11:00 – 11:59	12:00 – 12:59	1:00 – 1:59	2:00 – 2:59	3:00 – 3:59	4:00 – 4:59	5:00 – 5:59	6:00 – 6:59	7:00 – 7:59	8:00 – 8:59	9:00 – 9:59	10:00 – 10:59	11:00 – 11:59
Peak	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
Mid peak	0	0	0	0	0	0	0	0	1	1	1	X(1)	X	X	X	1	1	1	1	0	0	0	0	0

(1) x = Don't care.

Configuring the Time-of-Use Log

Perform a table write to Table A.55 Time-of-Use Configuration Table to set up the user-selectable options. This read/write table of 10 integer elements contains the following configuration and read-back selection parameters.

- *Password* – required for configuration. Use a valid password or -1 for read-back select. Range 0 – 9999, default 0, returns -1
- *Record to read back* – selects the record to be returned in the next read of Tables A.56, A.57 and A.58. Range 0 to 12, default 0
- *Write command* – stores record 0 to record 1 and shifts remaining records down. Range 0 (no action), 1 (execute write command), default 0
- *Log day* – selects the day of the month to automatically store the in-process record and shift the remaining records down. Range 0 to 31. 0 disables automatic store. 1 to 28 select the day of month, 29 to 31 select last day of month
- *Off-peak day* – selects day(s) of week during which all hours are off-peak. Bitfield, bit 0 = Sunday, bit 1 = Monday and so on. Range 0 to 127 (0 – FF Hex), default 65 (41 Hex, Saturday and Sunday)
- *Mid peak AM* – selects morning mid peak time-of-use hours. Bitfield, range 0 to 4095 (0 to 0FFF hex). See Time-of-use selection above. Default 1792 (700 Hex, 8:00 to 10:59 a.m.)
- *Mid peak PM* – selects afternoon mid peak time-of-use hours. Default 120 (78 Hex, 3:00 to 6:59 p.m.)

- *Peak AM* – selects morning peak time-of-use hours. Default 2048 (800 Hex, 11:00 to 11:59 a.m.)
- *Peak PM* – selects afternoon peak time-of-use hours. Default 7 (7 Hex, 12:00 noon to 2:59 p.m.)

Reading Time-of-Use Log Data

The Powermonitor 3000 stores the TOU log in three sets of 13 records each, one set for real energy and demand, a second for reactive energy and demand, and the last for apparent energy and demand. For each set, record 0 contains the in-process records for the current month. Records are stored to non-volatile memory every 2 minutes. Records 1 to 12 contain the monthly records for the previous 12 months. When the log day occurs, the records are shifted down, with the record 0 moving into record 1 and the oldest record being deleted.

Tables A.56 contains the real energy and demand time-of-use data from the record selected during the most recent write to Table A-55. This read-only table of 12 floating-point elements contains the following data:

- *Off-peak MWh*
- *Off-peak kWh*
- *Off-peak demand Watts*
- *Mid-peak MWh*
- *Mid-peak kWh*
- *Mid-peak demand Watts*
- *Peak MWh*
- *Peak kWh*
- *Peak demand Watts*
- *Start date* in YY/MM/DD format
- *End date* in YY/MM/DD format
- *Record number* 0 thru 12

Tables A.57 and A.58 are identical except that Table A.57 contains reactive energy and demand TOU data and Table A.58 contains apparent energy and demand TOU data.

Advanced Features

In this chapter we will discuss major features that, for the most part, are found only in the Powermonitor 3000 M6 and M8 models. The exception is that basic harmonic analysis is supported in the M4 and M5 models.

Oscillography

Oscillography captures waveforms of the voltage and current present at the Powermonitor 3000 input terminals. A client application reads oscillography records using the indexed read method. The main features of oscillography are:

- Simultaneous capture of all seven voltage and current channels
- Non-volatile storage of up to 8 (M6) or 2 (M8) captures
- Configurable sampling rate up to 5.4 kHz or 90 samples per cycle at 60 Hz
- Captures may hold up to 408 cycles of data per channel at 60 Hz
- Configurable data resolution of 13 bit w/ sign or 7 bit w/sign
- Configurable pre-trigger means the capture includes waveform information prior to the triggering event
- Setpoints or communications may trigger oscillogram captures
- All communications options support oscillography

You may choose to use RSPower32 or RSEnergyMetrix software, or create a custom application, to configure oscillography and read waveform data.

Configuring Oscillography

You may configure oscillography only via communications. The Display Module does not support an interface to oscillography. Configure oscillography by performing a table write to Table A.39 Oscillograph Configuration/Read-Back Data Select. This read/write table of 11 integer elements comprises the following configuration and command parameters.

- *Password:* needed to configure the capture type or pre-trigger, or execute a command to trigger or clear a capture. Not needed for read-back select, use -1. Default 0000.

- *Capture number:* selects a capture for read-back or returns the last capture selected. Range 1 to 8 (M6) or 1 to 2 (M8). Default 1.
- *Channel number:* selects a channel number or returns the last channel number selected. Range: 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4. Default 1.
- *Block number:* selects a data block for the next read or returns the last block selected. Range depends on communications type. See below. Default 1.
- *Read-back mode:* selects a read-back mode or returns the last mode selected. Range 0 to 2, default 0. See below.
- *Clear / trigger command:* clears one or all captures or triggers a new capture. Always returns 0. In the M8 model, values of 3 through 8 have same meaning as 0. Options are listed below:

  0 - no action
  1 - clear capture 1
  2 - clear capture 2
  3 - clear capture 3 (M6 only)
  4 - clear capture 4 (M6 only)
  5 - clear capture 5 (M6 only)
  6 - clear capture 6 (M6 only)
  7 - clear capture 7 (M6 only)
  8 - clear capture 8 (M6 only)
  9 - clear all captures
  10 - initiate a new capture

- *Capture type:* selects sample rate and data resolution or indicates selected sample rate and resolution. Range -1 to 5, default 0. -1 disables oscillography. See Table 8.1.
- *Pre-trigger:* specifies how much of the captured waveform occurred before the triggering event. Range 0 to 100 per cent, default 90%.
- *Reserved:* must be zero (0) on a write, returns 0.
- *Capture clear status:* Read-only bitfield that indicates which capture numbers are clear. Bit 0 (LSB) corresponds to capture 1, bit 1 to capture 2 and so on. For each bit, 1 indicates clear, 0 indicates not clear.
- *Capture ready status:* read-only bitfield that indicates which capture numbers contain captures that are ready to read. Same bit correspondence as above. For each bit, 1 indicates the capture is ready, 0 indicates no capture or not yet ready. If a client reads a capture that is not ready, -1 is returned for all data points.

Block Number

The block number and the total number of data reads required to read an entire capture depend on the communications option and the *capture type*. See Table 8.1. The block number range is 1 to the number of *Data reads required* listed in the table.

Capture Type

The properties associated with the capture type options are listed in Table 8.1. You may select a capture type that best suits your application requirements. A higher sample rate provides a more accurate representation of the waveform when higher-order harmonics and transients are present. Higher data resolution provides more accuracy of each data point. Capture type 5 combines low sampling rate and low resolution, but captures almost 7 seconds of waveform at 60 Hz.

Table 8.1 Capture Type Properties

Capture Type	Sampling Rate	Data Resolution	Samples per Cycle at 60 / 50 Hz	Total Cycles per Channel at 60 / 50 Hz	Capture Duration (seconds)	Data Reads Required	
						DeviceNet	Other Comms
0	5.4 kHz	13-bit w/sign	90 / 108	51.1 / 42.6	0.85	230	92
1	2.7 kHz		45 / 54	102.2 / 85.2	1.70		
2	1.35 kHz		22.5 / 27	204.4 / 170.3	3.40		
3	5.4 kHz	7-bit w/sign	90 / 108	102.2 / 85.2	1.70	460	184
4	2.7 kHz		45 / 54	204.4 / 170.3	3.40		
5	1.35 kHz		22.5 / 27	408.8 / 340.7	6.81		

Read-Back Mode

The data client uses the indexed read method to read oscillogram capture data. The readback mode options are:

- *Auto-increment all channels:* successive reads of Table A.40 increment through all remaining blocks of the current channel, increment through all remaining channels and wrap back to the original channel.
- *Auto-increment current channel:* successive reads of the results table will increment through all remaining blocks of the current channel only.

- *Manual increment:* each write of Table A.39 specifies the channel and block to be read in the next read of Table A.40. Successive reads of the results table will return the same block of data each time if no read-back select write is done.

Reading Oscillograph Data

Read oscillograph data from Table A.40 Oscillograph Results using the indexed read method. Oscillograph data is not available via Modbus communications. This read-only table comprises 29 (DeviceNet) or 59 (all other communications options) integer elements:

- *Capture timestamp:* in three elements using the standard timestamp format except the year is omitted
- *Capture number:* in the range 1 to 8 (M6) or 1 to 2 (M8)
- *Channel number:* in the range 1 to 7 (see above)
- *Block number:* block number of the data contained in the table (see above)
- *Capture type:* in the range of 1 to 5 (see table above)
- *Trigger statistics:* see below. Range 0 to 22,999.
- *Trigger position:* data point corresponding with the trigger position. See below.
- *Oscillograph data points:* See below.

The data client sets up the read-back configuration with a table write to Table A.39, the content of which is described above. As with other indexed reads, DeviceNet and Ethernet optional communications support only *manual increment* read-back mode so that the client must write a read-back select message before each read of the results table. For all other communications options, *auto-increment all channels* or *auto-increment current channel* read-back mode will provide the highest communications throughput.

Waveform Data Points

The results table contains 20 data points for optional DeviceNet communications or 50 data points for all other communications options. Data points are numbered 1 to 20 or 1 to 50 in each read. The client calculates each data point's place in the waveform using the following formula:

$$N_{\text{datapoint\_oscillogram}} = (N_{\text{block}} - 1) + N_{\text{datapoint\_this\_read}}$$

$N_{\text{datapoint\_oscillogram}}$ = the sequence number of the data point in the oscillogram channel
N_{block} = the block number
$N_{\text{datapoint\_this\_read}}$ = the data point number (1 to 20 or 1 to 50) in the current read

The total number of data points is 4600 for capture type 0, 1 and 2 and 9200 for capture types 3, 4 and 5.

Each data point is expressed in calibrated analog-to-digital (A/D) converter counts with a resolution of 8192 (13-bit w/sign) or 128 (7-bit w/sign). A client may calculate the primary-side instantaneous voltage or current magnitude of each data point using the following formula:

$$M_i = \frac{M_{(\text{max rms})} \bullet \sqrt{2}}{R_{max}} \bullet N_t \bullet M_{data}$$

Where:

- M_i = instantaneous value of the voltage or current data point
- $M_{(\text{max rms})}$ = max rms magnitude
  = 399.0 line-to-neutral volts for channels 1, 3 and 5
  = 691.1 line-to-line volts for channels 1, 3 and 5
  = 10.6 amperes for channels 2, 4, 6 and 7
- R_{max} = maximum resolution
  = 8192 for 13-bit w/sign, capture types 0, 1 and 2
  = 128 for 7-bit w/sign, capture types 3, 4 and 5
- N_t = PT or CT ratio
  = PT or CT primary / PT or CT secondary
- M_{data} = value of the data point from Table 39

For example, consider the following capture:

- PT primary = 13.8 kV
- PT secondary = 120 V
- CT primary = 100 A
- CT secondary = 5 A
- Delta voltage mode (line-to-line)
- Capture type = 2

You would multiply each data point by the following factor to correctly display the waveform:

$$Factor = (691.1 \bullet 1.414) / 8192 \bullet (13800 / 120) = 13.72$$

Trigger Statistics

The *trigger source* and *capture identifier* are combined in one element, and indicate what triggered the capture and a unique capture identifier or serial number. The value divided by 1,000 gives the trigger source: 0 = none; 1 to 20 = setpoint number; 21 = native communications; 22 = optional communications. The remainder of this calculation is the unique capture identifier which increments by 1 from 0 to 999 and rolls back to 0. A client application may use the identifier to associate with an event log entry and determine chronological order of captures. Example: a parameter value of 15347 indicates that setpoint 15 triggered the capture and its serial number or identifier is 347.

The *trigger position* returns the number of the data point corresponding with the time the capture was triggered. A client application may use this to place a marker on the displayed waveform. The maximum trigger position is the same as the total number of oscillogram data points. The Powermonitor 3000 configuration may affect the accuracy of the trigger position statistic with respect to the pre-trigger setting. For best results, set RMS resolution to 0 (nominal) and RMS results averaging to 0 (none) in Table A.6 Advanced Device Configuration.

The capture timestamp and capture type are also important statistics that identify the capture and enable a client application to correctly display the waveform.

Harmonic Analysis

The Powermonitor 3000 provides harmonic data to help you understand this important element of power quality in your facility. Each model provides a different level of harmonic information.

Table 8.2 provides an overview of the harmonic analysis available in each model. You may access all harmonic data using communications. The Display Module can access average values of the parameters as indicated in the DM column.

Table 8.2 Harmonic Analysis Functionality

Harmonic data	DM (Avg.)	M4 M5	M6	M8	Per current channel	Per voltage channel	Avg. of current channels	Avg. of voltage channels
IEEE Total Harmonic Distortion (THD)	•	•	•	•	•	•	•	•
IEC Distortion Index (DIN)	•	•	•	•	•	•	•	•
Crest Factor	•	•	•	•	•	•	•	•
Telephone Interference Factor (TIF)			•	•	•	•	•	•
K-factor			•	•	•	•	•	•
IEEE-519 Total Demand Distortion (TDD)			•	•	•			
IEEE 519 Pass / Fail			•	•	•	•		
Harmonic distortion, harmonics 1 to 41			•	•	•	•		
Harmonic magnitude, harmonics 1 to 41			•	•	•	•		
Harmonic distortion, harmonics 42 to 63				•	•	•		
Harmonic magnitude, harmonics 42 to 63				•	•	•		

IEEE THD and DIN

Both of these total harmonic distortion calculation methods provide a summary indication of the amount of distortion due to harmonics present in a system. The standard IEEE definition of harmonic distortion is "Total Harmonic Distortion (THD)" and is computed for each channel as follows:

$$THD = \frac{\sqrt{\sum_{n=2}^{\infty} (H_n)^2}}{H_1}$$

Where:

- H_n = magnitude of the n^{th} harmonic ($n \leq 41$ or 63)
- H_1 = magnitude of fundamental

The standard IEC definition of harmonic distortion is the "Distortion Index (DIN)" and is computed for each channel as follows:

$$DIN = \sqrt{\frac{\sum_{n=2}^{\infty} (H_n)^2}{\sum_{n=1}^{\infty} (H_n)^2}}$$

Where:

- H_n = magnitude of the n^{th} harmonic ($n \leq 41$ or 63)
- DIN is equivalent to IEC THD

Crest Factor

This is another quantity that is sometimes used to describe the amount of distortion present in a waveform. It can also be used to express the dynamic range of a measurement device. Crest Factor is the ratio of the peak to the RMS.

$$\text{Crest Factor} = \text{Peak Value} / \text{RMS Value}$$

A pure sinusoid Crest Factor equals $\sqrt{2}$.

TIF

Another method of measuring signal distortion is the Telephone Influence Factor, sometimes called the Telephone Interference Factor. This measurement is used to estimate the effect that the power line harmonics have on nearby analog telephone conductors. This method weighs each of the harmonics based on the physiological and audiological characteristics of the human ear. The harmonics are additionally weighted to reflect the relationship of harmonic frequency and degree of coupling to the phone lines. These weights are called single frequency TIF weights. The 1404-M6 uses the most recent TIF weights (updated in 1960). The single frequency factors are used to compute the total TIF. The user multiplies the TIF numbers by the RMS magnitude of the power lines voltage or current to obtain an index for estimating the amount of interfering energy that is coupled to the telephone system. The formula for total TIF is:

$$\text{TIF} = \frac{\sqrt{\sum_{i=1}^{\infty} (w_i X_i)^2}}{\sqrt{\sum_{i=1}^{\infty} (X_i)^2}}$$

Where:

- X_i = single frequency RMS current or voltage at harmonic *i*.
- w_i= single frequency TIF weighting factor at harmonic *i*.

K-Factor

K-Factor measures additional heating in a power transformer due to the harmonics in the power signal. These harmonics cause additional heating due to increased core losses that occur at higher frequencies. The increased losses are related to the square of the harmonic frequency. Therefore, a slight harmonic content can significantly

increase the heat rise in a power transformer. The additional harmonic heating may cause a transformer to exceed designed temperature limits even though the RMS current is less than the transformer rating. The K-Factor is used as justification to oversize a power transformer to allow extra margin for harmonic losses or to select an appropriate K-Factor rated transformer. A K-Factor rated transformer is the preferred choice since it has known performance in the presence of harmonics. The formula for K-Factor is as follows:

$$\text{K-Factor} = \frac{\sum_{n=1}^{\infty}\left(H_n^2 \bullet n^2\right)}{\sum_{n=1}^{\infty}(H_n)^2}$$

Where:

- H_n = magnitude of the n^{th} harmonic (n ≤41 or 63).

IEEE-519 TDD and IEEE-519 Pass/Fail

IEEE-519 is the IEEE standard for "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems". The 1404-M6 refers to the 1992 version of this standard. IEEE-519 provides recommended limits for the level of harmonic current injection at the Point of Common Coupling (PCC) between the utility and the user. The PCC is typically defined as the location in the power distribution system where the utility meters are connected. The standard provides recommended limits for individual harmonic components as well as a limit for Total Demand Distortion (TDD). Total Demand Distortion is defined as the root sum square of the current distortion expressed as a percent of the maximum fundamental demand load current (based on the maximum demand over the applicable demand interval). The formula for computing TDD is the same as the IEEE THD formula except the configured value for maximum fundamental load current is substituted for the magnitude of the measured fundamental load current.

$$\text{TDD} = \frac{\sqrt{\sum_{n=2}^{\infty}(H_n)^2}}{H_1}$$

Where:

- H_n = magnitude of the n^{th} harmonic (n ≤41 or 63)
- H_1 = maximum fundamental load current

Table 10.3 of the standard specifies the limits. The appropriate limits are selected by computing the ratio of the available short circuit current to the maximum fundamental demand load current. The row of the table that corresponds to the ratio is then used to determine the

proper limits for each of the individual harmonics and the TDD specified in the table columns. IEEE-519 also recommends maximum voltage distortion levels that the utility should remain below. Table 11.1 specifies these limits based on the magnitude of the line to line voltage at the PCC. Once configured, the 1404-M6 will automatically monitor the system voltage and current for IEEE-519 compliance.

Harmonic Magnitude

The Powermonitor 3000 calculates the RMS magnitude of each individual harmonic. Results are calculated for harmonics 1 to 41 (M6) or 1 to 63 (M8) for all 7 voltage and current channels. Each result is expressed in RMS volts or amps.

Harmonic Distortion

The Powermonitor 3000 calculates the magnitude of each individual harmonic with respect to the fundamental. Results are calculated for harmonics 1 to 41 (M6) or 1 to 63 (M8) for all 7 voltage and current channels. Each result is expressed as a percentage of the fundamental.

Configuring Harmonic Analysis

You may configure harmonic analysis only via communications. The Display Module does not support harmonic analysis configuration. Configure harmonic analysis by performing a table write to Table A.33 Harmonic Analysis Configuration/Read-Back Select. This read/write table of 9 integer elements comprises the following configuration parameters.

- *Password:* needed to enable or disable harmonic analysis or write the maximum short-circuit and demand current parameters. Not needed for read-back select, use -1. Default 0000
- *Channel:* Specifies the channel of harmonic data to obtain in the next read of Table 33. 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4, 8 = avg. of voltage channels, 9 = avg. of current channels. On a read, indicates the last selection made. Default 1
- *Read-back mode:* selects read-back mode for Table A.34. Range 0 to 1, default 0. See below

TIP The remaining elements listed below are reserved in the M4 and M5 models, return 0 on a read and must be 0 on a write.

- *Individual harmonic data type:* selects% distortion (0) or magnitude (1) on subsequent reads of the individual results tables. Default 0
- *Enable disable harmonic analysis:* 0 disables, 1 enables calculation of TIF, K-factor, IEEE-519 and individual harmonics results. Default 1
- *IEEE-519 maximum short-circuit current:* used for IEEE-519 pass/fail calculation, expressed in integer/exponent format. Range 0 to 9999 (integer), -4 to 21 (exponent), defaults are 0.
- *IEEE-519 maximum demand load current:* used for IEEE-519 TDD calculation, expressed in integer/exponent format. Range 0 to 9999 (integer), -4 to 21 (exponent), defaults are 0.

Readback Mode

The data client uses the indexed read method to read harmonic analysis and individual harmonic data. The options are:

- *Auto-increment (0):* increments the channel after each read of Table A.34. This also controls the read-back channel for individual harmonics results tables. If you use the auto-increment mode, read any desired individual harmonic data for the current channel before the next read of Table A.34.
- *Manual-increment (1):* successive reads of Table A.34 will return harmonic results from the current channel.

As with other indexed reads, DeviceNet and Ethernet optional communications support only *manual increment* read-back mode so that the client must write a read-back select message to change the channel returned in the results table. For all other communications options, *auto-increment* read-back mode will provide the highest communications throughput.

Reading Harmonic Analysis Data

The Powermonitor 3000 presents harmonic analysis results in Table A.34 Harmonic Results; THD, Crest Factor, and More. This read-only table contains 9 floating-point elements in the M4 and M5

models and 10 floating-point elements in the M6 and M8 models. The table contains the following parameters.

- *Channel number:* the voltage or current channel being returned. See above
- *% IEEE THD:* Total harmonic distortion in per cent based on the IEEE definition. Range 0.0 to 1000.0
- *% IEC THD (DIN):* Total harmonic distortion in per cent based on the IEC definition. Range 0.0 to 1000.0
- *Crest factor:* Range 0 to 10
- *THD & Crest iteration:* each new calculation increments by one from 0 to 32,767 and rolls back to 0

TIP The remaining elements are reserved in the M4 and M5 models and return values of 0.

- *TIF:* Telephone influence factor. Range 0.0 to $999.9*10^{22}$
- *K-factor:* Range 0.0 to $999.9*10^{22}$
- *IEEE-519 TDD:* Total demand distortion. Range 0.0 to $999.9*10^{22}$
- *IEEE-519 Pass/fail:* -1 = unknown, 0 = fail, 1 = pass
- *FFT iteration:* each new FFT calculation (used in the previous four parameters) increments by one from 0 to 32,767 and rolls back to 0

A data client may determine the relative freshness of data by comparing the *THD & crest iteration* or *FFT iteration* parameters in repeated reads of this table.

Reading Individual Harmonic Values

The M6 and M8 models provide several data tables containing individual harmonic results. Individual harmonic value data is not available via Modbus communications. Write to Table A.33 to select the read-back mode, data type (magnitude or distortion per cent) and/or channel number of harmonic data. A data client reads the tables listed below in indexed read-back mode to obtain individual harmonic data. In auto-increment mode, read Table A.34 to index the channel.

- Table A.35 Harmonic Results; Odd Harmonics 1 to 21 (M6 and M8)

- Table A.36 Harmonic Results; Odd Harmonics 23 to 41 (M6 and M8)
- Table A.37 Harmonic Results; Even Harmonics 2 to 20 (M6 and M8)
- Table A.38 Harmonic Results; Even Harmonics 22 to 40 (M6 and M8)
- Table A.48 Harmonic Results; Odd Harmonics 43 to 63 (M8 only)
- Table A.49 Harmonic Results; Even Harmonics 42 to 62 (M8 only)

Each of these tables consists of 14 floating-point elements containing the following parameters:

- *Channel:* 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4 (no averages)
- *Type of harmonic data:* 0 = per cent harmonic distortion, 1 = magnitude
- *Nth harmonic:* expressed according to the *type* parameter. Magnitude type is referenced to the primary side of PTs and CTs. Range: 0.0 to 999.9 * 10^{22}
- *FFT iteration:* each new FFT calculation (used in the previous four parameters) increments by one from 0 to 32,767 and rolls back to 0

In Tables A.36, A.37 and A.38 the first *nth harmonic* element is reserved and returns a value of 0.

Sag and Swell

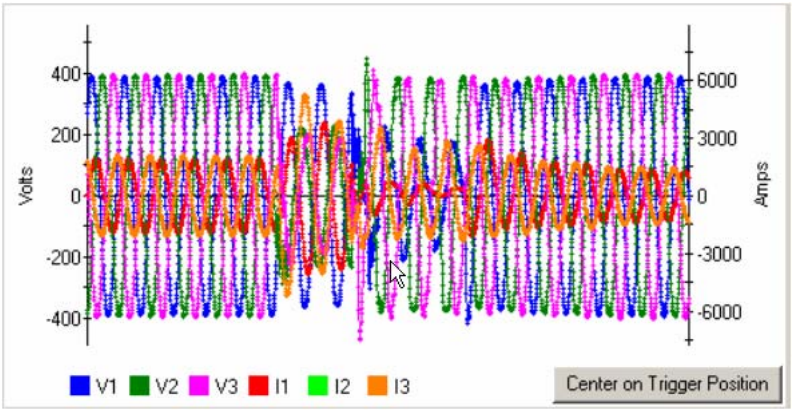
The Powermonitor 3000 M6 and M8 models are is capable of detecting voltage sags and swells. There are many definitions for sag and swell. IEEE 1159[1] defines sag as:

> "A decrease to between 0.1 and 0.9 pu in rms voltage or current at the power frequency for durations of 0.5 cycle to 1 minute".

IEEE 1159[1] defines swell as:

> "An increase in rms voltage or current at the power frequency for durations from 0.5 cycles to 1 minute. Typical values are 1.1-1.8 pu".

Figure 8.1 Sag and Swell



The pre-defined setpoint configuration for the detection of sag and swell is based on the IEEE-1159 standard. Although the default setpoint configuration is applicable as-is for many sag and swell applications, it may be necessary to alter the setpoint configuration to adjust the unit's sensitivity to sags and swells for your particular application.

Setpoint #19 is setup to detect voltage sag and has the following configuration data:

- Type = Voltage Sag
- Evaluation condition = Under forward
- High Limit = 90% Nominal System Voltage
- Low Limit = 90% Nominal System Voltage
- Action delay = 0
- Release delay = 0
- Output action = Capture oscillograph

Setpoint #20 is setup to detect voltage swell and has the following configuration data:

- Type = Voltage Swell
- Evaluation condition = Over forward
- High Limit = 110% Nominal System Voltage
- Low Limit = 110% Nominal System Voltage
- Action delay = 0
- Release delay = 0
- Output action = Capture oscillograph

TIP Refer to Chapter 5, Setpoint Programming and Operation for more information on setpoints.

If the nominal system voltage setting is changed, the high and low limits for setpoint #19 and #20 are automatically adjusted to 90% and 110% of the nominal system voltage.

To effectively use sag and/or swell detection:

1. Set 'RMS result averaging' to 0 (no averaging) for the quickest setpoint response to changes in input voltage.
2. Alter setpoint configuration if necessary to adjust the sensitivity to sags and/or swells.
3. If using the setpoint to trigger an oscillograph capture, make sure there is at least one capture location that is clear and ready to accept a new capture.
4. Periodically check the event log or capture ready status for an indication that a sag or swell has occurred.
5. Read the event log to get the timestamp, duration of the disturbance, the worst case magnitude, and the identifier of the capture.
6. Find the capture that has the same identifier as the one found in the event log record by reading the first block from each capture location. Read the entire capture from the Powermonitor 3000. Depending on the duration of the disturbance, the capture may contain additional information prior to and during the sag or swell event.

The sag or swell duration reported in the event log has a tolerance of ± 2x the metering update rate. Refer to Metering Update Rate on page 3-33 for more information. For sag and swell durations less than 500 milliseconds, examining the oscillograph data can result in a more accurate determination of sag or swell duration.

References:

IEEE Std 1159-1995, "IEEE Recommended Practice for Monitoring Electric Power Quality", page 5,6,12.
The Institute of Electrical & Electronics Engineers Inc, 345 East 47th Street, New York, NY 10017-2394, ISBN 1-55937-549-3

Load Factor

The Powermonitor 3000 M6 and M8 models provide a *Load Factor Log* which calculates and stores a group of plant demand metrics that indicates how stable (or, conversely, how dynamic) a load is over a period of time, usually one month. Use communications to configure load factor operation and read the results. The Display Module does not support an interface to the load factor log.

Load factor is the average demand divided by the peak demand for the month. If the load is constant, load factor is 100%. The Powermonitor 3000 calculate load factor for real, reactive and apparent power and current, and stores the last 12 results in the Load Factor Log in non-volatile memory. You may configure the Powermonitor 3000 to automatically calculate and store load factor on a particular day each month, or you may manually generate a command using communications to save the load factor result and reset the calculation. You will find information useful in reducing peak demand when you look at load factor and peak demand values. The peak demand period is stored in the Mix/Max Log, which has a date and time stamp that indicates when the peak occurred. Using this information, you may be able to identify plant activities that caused the peak. You may be able to prevent or reschedule activities, or install a demand management system. Either option may realize significant savings in demand charges. You can use the load factor values to estimate demand cost savings potential. The lower the load factor, the higher the potential for savings by managing your electric power demand.

The Powermonitor 3000 stores the load factor in 13 records. Record 0 stores in-progress calculations and will be cleared on a power cycle. Records 1 through 12 are a first-in, first-out array saved in non-volatile memory, with the highest record number containing the most recent record. In manual clear/reset mode, when you issue a clear/reset command, the contents of record 0 is written to the highest-numbered record and (if necessary) the remaining records are shifted down, with the oldest being deleted. In auto clear/reset mode, you select a day of the month for this process to occur automatically.

Within each record, the Powermonitor 3000 stores peak, average and load factor values for real power (watts), reactive power (VARs) apparent power (VA) and average current (amps). Peak values are the largest such value that has occurred since the last automatic or manual clear/reset occurrence. The in-process record (record 0) is updated at the end of each demand interval. If no demand interval has expired since the last unit power-up, the record will return all zeroes.

Reading the Load Factor Log

To select the read-back mode or record, an auto reset/store day of the month, or issuing a manual reset/store command, perform a table write to Table A.41. Load factor log data is not available via Modbus communications. This read/write table contains 6 integer elements as follow:

- *Password:* required for changing the auto clear/reset day or manual clear/reset command. Use -1 if only selecting read-back mode or record. Range 0000 to 9999, default 0000. Returns -1
- *Record select:* selects the next read-back record
- *Read-back mode:* 0 = auto-increment record number after each read, 1 = manual increment. Auto-increment not supported in DeviceNet and Ethernet optional communications.
- *Manual clear/reset command:* 0 = do nothing, 1 = manual clear/reset command (see above)
- *Auto clear/reset day:* Selects the day of month for automatically storing and clearing the current in-process record. Range 0 to 31; 0 disables automatic clear/reset, 1 to 28 selects day of month, 29 to 31 selects last day of month
- *Reserved:* reserved element must be 0 on a write, returns 0

The results table is Table A.42. You may read the in-process Record 0 or one of the 12 logged records. This table contains the following 14 floating-point elements:

- *Peak demand power:* expressed in watts. Range 0.0 to $999.9*10^{21}$
- *Average demand power:* expressed in watts. Range 0.0 to $999.9*10^{21}$
- *Load factor power:* expressed in per cent. Range 0.0 to 100.0
- *Peak demand reactive power:* expressed in VARs. Range 0.0 to $999.9*10^{21}$
- *Average demand reactive power:* expressed in VARs. Range 0.0 to $999.9*10^{21}$
- *Load factor reactive power:* expressed in per cent. Range 0.0 to 100.0
- *Peak demand apparent power:* expressed in VARs. Range 0.0 to $999.9*10^{21}$
- *Average demand apparent power:* expressed in VARs. Range 0.0 to $999.9*10^{21}$
- *Load factor apparent power:* expressed in per cent. Range 0.0 to 100.0

- *Peak demand current:* expressed in VARs. Range 0.0 to $999.9*10^{21}$
- *Average demand current:* expressed in VARs. Range 0.0 to $999.9*10^{21}$
- *Load factor current:* expressed in per cent. Range 0.0 to 100.0
- *Elapsed time:* hours that have elapsed since the last automatic or manual clear/reset operation
- *Ending date:* for this load factor record. Range 0 to 123199 (mmddyy). 0 if the selected record is blank

Transient Detection, Metering and Capture

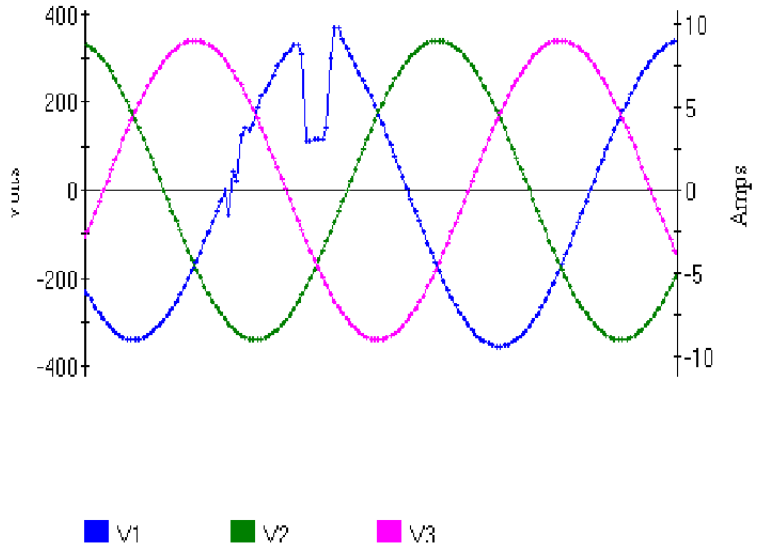
Transient detection functionality, available only in the M8 model, continuously monitors your choice of voltage or current inputs for the occurrence of a transient. Transients such as voltage spikes and momentary dropouts can disrupt equipment connected to the power source, but can be difficult to detect. Use communications to configure transient capture parameters and retrieve the data for display and/or processing. The Display Module does not support an interface for transient detection. Transient detection:

- Continuously monitors all 3 voltage or 3 current channels
- Identifies transients at least 200 microseconds in duration
- Triggers a transient oscillogram capture when it detects a transient
- Records captures each containing 12 cycles; 6 cycles preceding and 6 cycles following the transient
- Stores up to six transient captures of all 7 voltage and current channels in non-volatile memory
- Calculates RMS voltage and current values for each cycle in each capture
- Stores each data point in the capture with 13-bit plus sign resolution
- Monitors for transients on your choice of voltage channels or current channels
- Automatically or manually adjusts transient detection thresholds

You may configure a detected transient to trigger a setpoint, which may then trigger an oscillogram capture, providing “zoom” capability. All communications options support transient configuration, metering and capture.

Use RSPower32 or RSEnergyMetrix software, or create a custom application, to configure and read transient data. The following information provides details of the data table interface for transient detection.

Figure 8.2 Transient Capture



Transient Analysis Configuration

Perform a table write to Table A.43 Transient Analysis Configuration/Read-Back Select to configure transient analysis. This read/write table of 13 floating-point elements contains the following configuration, command and read-back select parameters:

- *Password:* required for configuration and command. Use a valid password or -1 for read-back select. Range 0000 to 9999, default 0, returns -1
- *DeviceNet unique write identifier:* range -32,768 to 32,767, default 0
- *Capture number:* selects a capture for read-back. Range 0 to 6, default 1
- *Cycle number:* selects a cycle for read-back. Range 1 to 12, default 1
- *Read-back mode:* 0 = auto-increment mode; cycle number increments after each read of Table A.44. 1 = manual-increment mode; only mode supported by DeviceNet and Ethernet communications. Default 0
- *Detection mode:* selects channels to monitor. 0 disables transient detection, 1 = voltage channels only, 2 = current channels. Default 1
- *Auto-threshold set command:* 0 = do nothing, 1 = set threshold. Default 0
- *Auto-threshold set duration:* range: 1 to 3600 seconds, default 10

- *Auto-threshold set margin:* range 1.0 to 100.0 per cent, default 20.0
- *Voltage trigger threshold:* range 0.1 to 1000.0, default 10.0
- *Current trigger threshold:* range 0.1 to 1000.0, default 10.0

Threshold Configuration

The Powermonitor 3000 compares voltage or current transients against a threshold that you may set manually or command to be set automatically. You select either voltage channels or current channels with the *Detection mode* parameter.

When you issue the *Auto-threshold set command*, the Powermonitor 3000 first determines if there is sufficient signal amplitude on the selected voltage or current channels to set the threshold. If the signal amplitude is greater than 10% of full-scale, the Powermonitor 3000 begins timing the *Auto-threshold set duration*. During this time, it monitors the selected channels, calculates an average transient index, and decrements the *Auto-threshold duration time remaining* parameter. At the end of this time, it combines the average transient index with the *Auto-threshold set margin* and stores the result as the *Voltage trigger threshold* or *Current trigger threshold*.

Threshold settings relate to both magnitude and duration of a transient, so they are representative of the energy contained in a transient. In most cases, use the automatic threshold calculation as a starting point, by issuing an *Auto-threshold set command*. Then manually adjust the selected threshold if you want to increase or decrease the sensitivity.

The Powermonitor 3000 will not monitor for or capture transient data until a threshold setting has been configured.

Reading Transient Analysis Metering Data

The Powermonitor 3000 M8 model presents 12 cycles of transient metering results for each of up to 6 transient captures in Table A.44. Transient analysis metering data is not available via Modbus communications. This read-only table of 14 floating-point elements contains the following metering results and capture statistics:

- *Capture number:* transient capture number associated with the metering results. Range 1 to 6
- *Cycle number:* which cycle in the capture is returned in this read. Range 1 to 12

- *Voltage:* three RMS voltage results that express line-to-line (delta wiring modes) or line-to-neutral (all other wiring modes) for the current *Cycle number*. Range 0.0 to 999.0 * 10^{21}
- *Current:* four RMS current results (L1, L2, L3, L4) for the current *Cycle number*. Range 0.0 to 999.0 * 10^{21}
- *Trigger channel:* indicates which channel caused the transient capture. 1=V1, 2=I1, 3=V2, 4=I2, 5=V3, 6=I3, 7=I4
- *Index at trigger:* the value of the transient index at the time of the capture. Range -999.0 * 10^{3} to 999.0 * 10^{3}
- *Voltage and Current trigger thresholds:* at the time of the transient capture. Range 0.0 to 999.0 * 10^{3}
- *Capture ID:* unique identifier that increments by 1s to 30,000 and then rolls over to 0

Read this data table using an indexed read method. Select the *Read-back Mode, Capture* and *Cycle* by writing to Table A.43.

Reading Transient Capture Data

The data client sets up the read-back configuration with a table write to Table A.45 Transient Capture Clear/Read-Back Data Select. Transient capture data is not available via Modbus communications. This read/write table of 13 integer elements contains the following

- *Password:* required for *Clear* command, use -1 for read-back selections
- DeviceNet unique write identifier
- *Capture number:* selects one of 6 captures or returns the last capture number selected. Range: 0 = most recent capture initiated via communications, 1 through 6 = capture #1 through #6, default 1.
- *Channel number:* selects a channel number or returns the last channel number selected. Range: 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4, default 1.
- *Block number:* selects a data block for the next read or returns the last block selected. Range depends on communications type. See below. Default 1.
- *Read-back mode:* selects a read-back mode or returns the last mode selected. Range 0 to 2, default 0. See below.
- *Clear command:* clears one or all captures. Always returns 0. See below
- *Reserved elements:* must be zero (0) on a write, returns 0.

- *Capture clear status:* Read-only bitfield that indicates which capture numbers are clear. Bit 0 (LSB) corresponds to capture 1, bit 1 to capture 2 and so on. For each bit, 1 indicates clear, 0 indicates not clear.
- *Capture ready status:* read-only bitfield that indicates which capture numbers contain captures that are ready to read. Same bit correspondence as above. For each bit, 1 indicates the capture is ready, 0 indicates no capture or not yet ready.

Block Number

The block number and the total number of data reads required to read an entire capture depend on the communications option. The range is 1 to 70 for DeviceNet and 1 to 28 for all other communications options.

Read-Back Mode

The data client uses the indexed read method to read transient capture data. The readback mode options are:

- *Auto-increment all channels:* successive reads of Table A.45 increment through all remaining blocks of the current channel, increment through all remaining channels and wrap back to the original channel.
- *Auto-increment current channel:* successive reads of the results table will increment through all remaining blocks of the current channel only.
- *Manual increment:* each write of Table A.45 specifies the channel and block to be read in the next read of Table A.46. Successive reads of the results table return the same block of data each time if no read-back select write is done.

As with other indexed reads, DeviceNet and Ethernet optional communications support only *manual increment* read-back mode so that the client must write a read-back select message before each read of the results table. For all other communications options, *auto-increment all channels* or *auto-increment current channel* read-back mode will provide the highest communications throughput.

Table A.46 comprises the transient capture results. This read-only table comprises 29 (DeviceNet) or 59 (all other communications options) integer elements:

- *Capture timestamp:* in three elements using the standard timestamp format except the year is omitted
- *Capture number:* in the range 1 to 6

- *Channel number:* in the range 1 to 7 (1=V1, 2=I1, 3=V2, 4=I2, 5=V3, 6=I3, 7=I4)
- *Block number:* block number of the data contained in the table. See above.
- *Transient capture identifier:* range 0 to 30,000, rolls over to 0
- *Transient capture data points:* see below

Transient Capture Data Points

The results table contains 20 data points for optional DeviceNet communications or 50 data points for all other communications options. Data points are numbered 1 to 20 or 1 to 50 in each block. The block number ranges from 1 to 70 for DeviceNet and 1 to 28 for all other communications options. The client calculates each data point's place in the transient capture using the following formula:

$$N_{\text{datapoint\_capture}} = (N_{\text{block}} - 1) + N_{\text{datapoint\_this\_read}}$$

$N_{datapoint\_capture}$ = the sequence number of the data point in the capture channel
N_{block} = the block number
$N_{datapoint\_this\_read}$ = the data point number (1 to 20 or 1 to 50) in the current read

The total number of data points is 1400. Each data point is expressed in calibrated analog-to-digital (A/D) converter counts with a resolution of 8192 (13-bit w/sign). A client may calculate the primary-side instantaneous voltage or current magnitude of each data point using the following formula:

$$M_i = \frac{M_{(\text{max rms})} \bullet \sqrt{2}}{R_{max}} \bullet N_t \bullet M_{data}$$

M_i = instantaneous value of the voltage or current data point
$M_{(max\ rms)}$ = max rms magnitude
= 399.0 line-to-neutral volts for channels 1, 3 and 5
= 691.1 line-to-line volts for channels 1, 3 and 5
=10.6 amperes for channels 2, 4, 6 and 7
R_{max} = maximum resolution
= 8192 for 13-bit w/sign
N_t = PT or CT ratio
= PT or CT primary / PT or CT secondary
M_{data} = value of the data point from Table A.46

For example, consider the following capture:

- PT primary = 13.8 kV
- PT secondary = 120 V

- CT primary = 100 A
- CT secondary = 5 A
- Delta voltage mode (line-to-line)

You would multiply each data point by the following factor to correctly display the waveform:

$$Factor = (691.1 \bullet 1.414) / 8192 \bullet (13800 / 120) = 13.7$$

Capture Statistics

The *Capture timestamp* and *Capture identifier* are important statistics that identify the capture. A data client may use the *Capture identifier* to associate the transient capture with corresponding metering data and event log data.

Clear Command

Issue the *Clear command* parameter to clear transient captures from non-volatile memory and provide space for new captures. Write the correct *Password* for the Powermonitor 3000 to accept the command. The command parameter options are:

-1 - Clear all transient captures
0 - No action
1 - Clear capture #1
2 - Clear capture #2
3 - Clear capture #3
4 - Clear capture #4
5 - Clear capture #5
6 - Clear capture #6

At least one capture location must be clear for a transient detect event to be processed. If no captures are clear, the Powermonitor 3000 ignores any new transient detection events.

Powermonitor 3000 Data Tables

This section provides the detailed data table definitions you may use for setting up communications with a Powermonitor 3000. One set of data tables covers all the Powermonitor 3000 models (M4, M5, M6, and M8) and communications options (-000, -232, -RIO, -DNT, -ENT and -CNT). The individual tables include notes regarding their applicability to various models and communications options. Please note carefully these designations.

Table A.1 summarizes the purpose and general attributes of each data table and lists each data table's access method (read-only or read/write), addressing options, number of elements and Powermonitor 3000 model applicability. Table A.2 through Table A.59 provide comprehensive details of the individual data tables along with application notes. For your convenience, summary information from Table A.1 is repeated at the top of each individual table.

Table A.1 Summary of Powermonitor 3000 Data Tables for all Communications Options

Data Table Name and Description	Data Access	Indexed Reads[2]	File No.[3] (DF1, CSP)	Remote I/O BT Size	Assy Instance (CIP, DNet)	Modbus Starting Address	No. of Elements	Applies to M4, M5	Applies to M6	Applies to M8	Configur-able	Refer to
Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging	R/W	-	-	I/O	1,2	-	-[5]	•	•	•	•[12]	Table A.2
Discrete Data	R		N9	10	3	30001	6	•	•	•		Table A.3
Basic Device Configuration	R/W		F10	20	4,5	40001	8 or 9[6]	•	•	•		Table A.4
Date and Time	R/W		N11	12	6,7	40101	8	•	•	•		Table A.5
Advanced Device Configuration	R/W		N12	26	8,9	40201	26	•	•	•		Table A.6
Native Communication Configuration	R/W		N13	11	10,11	40301	7	•	•	•		Table A.7
Optional Communication Configuration	R/W		N14	24	12,13	40401	20	•	•	•		Table A.8
Metering Voltage, Current and Frequency Result	R		F15	38	14	30101-2	14	•	•	•		Table A.9
Metering Sequence Voltage and Current Results	R		F16	27	15	30201-2	11	•	•	•		Table A.10
Metering Power Results	R		F17	31	16	30301-2	13	•	•	•		Table A.11
Metering Demand Results	R		F18	25	17	30401-2	10	•	•	•		Table A.12
Metering Power Factor Results	R		F19	33	18	30501-2	13	•	•	•		Table A.13
Metering Real and Apparent Energy Results	R/W		N20	29	19,20	40501	23	•	•	•		Table A.14
Metering Reactive Energy and Amp-Hour Results	R/W		N21	30	21,22	40601	23	•	•	•		Table A.15
Selftest/Diagnostic Results	R		N22	36	23	30601	27	•	•	•		Table A.16
DF1 PCCC Diagnostic Status Reply	R		[4]	-	-	-	-	•	•	•		Table A.17
Setpoint Setup/Read-Back Select and Status	R/W	•	N23	22	24,25	40701	16	•	•	•		Table A.18
Trend Log Configuration/Read-Back Record Select	R/W		N24	34	26,27	40801	26	•	•	•		Table A.21
Trend Log Results	R	•	F25	48	28	30701-2	14 or 22[7]	•	•	•	•	Table A.22
Min/Max Log Configuration/Read-Back Select	R/W		N26	13	29,30	40901	9	•	•	•		Table A.23
Min/Max Log Results	R	•	F27	28	31	30801-2	11	•	•	•		Table A.25
Event Log Configuration/Read-Back Record Select	R/W		N28	9	32,33	41001	6	•	•	•		Table A.26
Event Log Results	R	•	N29	21	34	30901	14,17,18[8]	•	•	•		Table A.27
User-Configured Table Setup	R/W		N30	35	35,36	41101	26	•	•	•		Table A.30
User-Configured Table Results	R		F31	62	37	31001-2	14 or 23[9]	•	•	•	•	Table A.31
Write Error Status	R		N32	4	38	31101	2	•	•	•		Table A.32
Harmonic Analysis Configuration/Read-Back Select	R/W		N33	14	39,40	41201	9	•	•	•		Table A.33
Harmonic Results; THD, Crest Factor, and More	R	•	F34	23	41	31201-2	9 or 10[10]	•	•	•		Table A.34
Harmonic Results; Odd Harmonics 1 to 21	R	•	F35	39	42	-	14		•	•		Table A.35
Harmonic Results; Odd Harmonics 23 to 41	R	•	F36	40	43	-	14		•	•		Table A.36
Harmonic Results; Even Harmonics 2 to 20	R	•	F37	41	44	-	14		•	•		Table A.37
Harmonic Results; Even Harmonics 22 to 40	R	•	F38	42	45	-	14		•	•		Table A.38
Oscillograph Configuration/Read-Back Data Select	R/W		N39	15	46,47	-	11		•	•		Table A.39
Oscillograph Results	R	•	N40	61	48	-	29 or 59[11]		•	•		Table A.40
Load Factor Log Configuration/Read-Back Select	R/W		N41	16	49,50	-	6		•	•		Table A.41
Load Factor Log Results	R	•	F42	43	51	-	14		•	•		Table A.42
Transient Analysis Configuration/Read-Back Select	R/W		F43	44	52,53	-	13			•		Table A.43

Table A.1 Summary of Powermonitor 3000 Data Tables for all Communications Options

Data Table Name and Description	Data Access	Indexed Reads(2)	File No.(3) (DF1, CSP)	Remote I/O BT Size	Assy Instance (CIP, DNet)	Modbus Starting Address	No. of Elements	Applies to			Configur-able	Refer to
								M4, M5	M6	M8		
Transient Analysis Metering Results	R	•	F44	32	54	-	14			•		Table A.44
Transient Capture Clear/Read-Back Data Select	R/W		N45	17	55,56	-	13			•		Table A.45
Transient Capture Results	R	•	N46	60	57	-	29 or 59(11)			•		Table A.46
Advanced Metering Configuration	R/W		N47	19	58,59	-	10			•		Table A.47
Harmonic Results; Odd Harmonics 43 to 63	R	•	F48	45	60	-	14			•		Table A.48
Harmonic Results; Even Harmonics 42 to 62	R	•	F49	46	61	-	14			•		Table A.49
Event Log Text	R/W	•	N50	37	62,63	-	23			•		Table A.50
Catalog Number and WIN	R		N51	50	64	32301	29	•	•	•		Table A.51
Network Demand Sync and Time Configuration(1)	R/W		N52	-	65, 66	41901	20	•	•	•		Table A.52
Controller Command(1)	W		N53	-	67	42601	1	•	•	•		Table A.53
Daylight Saving Time Configuration	R/W		N54	47	68,69	42100	10	•	•	•		Table A.54
Time of Use Register Configuration	R/W		N55	49	70,71	42200	10	•	•	•		Table A.55
Time of Use Records – Real Energy and Demand	R		F56	51	72	32300	12	•	•	•		Table A.56
Time of Use Records – Reactive Energy and Demand	R		F57	52	73	32400	12	•	•	•		Table A.57
Time of Use Records – Apparent Energy and Demand	R		F58	53	74	32500	12	•	•	•		Table A.58

(1) Supported only on 1404-xxxxx-ENT-xx Series B modules.

(2) Data is most commonly read from this table using the Indexed read method. Refer to Indexed reads of large data .

(3) Powermonitor 3000 starts with file 9 to avoid any data-type incompatibility with SLC file numbers 1 through 8, which are of a fixed data type.

(4) This is a reply to a PCCC diagnostic status request, used by RSWho to display text and an icon for the product.

(5) Remote I/O tables and the default DeviceNet input channel are PLC/SLC compatible, but if the user reconfigures the DeviceNet input channel (Instance 1), it may or may not be PLC/SLC compatible (depending on the number of parameters configured).

(6) Basic device configuration data table size is 8 elements for the M4 and M5, and 9 elements for the M6 and M8.

(7) The size of the Trend log results table is 28 elements for DeviceNet and 44 elements for all other communication protocols.

(8) The size of the Event log results table is 14 elements for M4/M5, 17 elements for M6 and 18 elements for the M8.

(9) The User-configured table results table is populated from the bottom up with the number of parameters the user has configured. The DeviceNet table must contain 14 elements or less to remain PLC/SLC compatible.

(10) Harmonic results; THD, crest factor, and more data table size is 18 elements for the M4 and M5 and 20 elements for the M6 and M8.

(11) The Oscillograph results and Transient capture results tables are 29 elements for DeviceNet and 59 elements for all other communication protocols.

(12) The I/O table is user configurable for DeviceNet and EtherNet/IP only (Instance 1).

Table A.2 Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging

CSP File No.	N/A
Remote I/O BT	N/A
CIP Assy. Inst.	1 (Read), 2 (Write)
No. of Elements	2 (Default)
User Configurable	Yes (DeviceNet, EtherNet/IP and ControlNet)
Data Type	Integer (Selectable as Floating Point with DeviceNet, EtherNet/IP and ControlNet)
Data Access	Read/Write
PM3000 Type	All

Remote I/O Discrete Data Provided by Powermonitor (Remote I/O Input Data)

Element No.	Element name	Range	Comment	
1	Relay, KYZ, and alarm bits	-	Bit	Description
			00-07	Reserved, used internally for BT information
			08	Form C relay state (setpoint output flag 1) 0 = De-energized & not forced 1 = Energized & not forced
			09	KYZ output state (setpoint output flag 2) 0 = De-energized & not forced 1 = Energized & not forced
			10	Setpoint output flag 3 state
			11	Setpoint output flag 4 state
			12	Setpoint output flag 5 state
			13	Setpoint output flag 6 state
			14	Setpoint output flag 7 state
			15	Setpoint output flag 8 state
2	Status input bits		Bit	Description
			00	Status input 1 state
			01	Status input 2 state
			02-05	Reserved, returns 0
			06	New oscillograph (M6, M8 only) Indicates at least one capture has been triggered, saved, and is ready to be read. This bit is cleared when all captures are cleared.
			07-11	Reserved, returns 0
			12-14	Reserved, used internally for BT information
			15	Reserved, returns 0

TIP

Data appears in the first two words of the input image table corresponding to the Powermonitor 3000 logical rack. For example, with the unit configured as Rack 1, Group 1 in a 1747-SN scanner residing in Slot 2, the data will appear in words I:2.8 and I:2.9 of the data table.

Remote I/O Discrete Data Accepted by Powermonitor (Master Output Data)

Element No.	Element name	Range	Comment
1	Relay control	0 or 128	0 (Bit 8 = 0): De-energize 128 (Bit 8 = 1): Energize Must be enabled by *Control source* parameter
2	KYZ control		

DeviceNet, EtherNet/IP and ControlNet I/O Data Provided by Powermonitor (Scanner Input Data; Instance 1)

Element No.	Element name	Range	Comment
0	Relay output status	0 to 3	0 = De-energized & not forced 1 = Energized & not forced 2 = Forced de-energized 3 = Forced energized
1	Solid-state KYZ output status		
2	Alarm output word	0 to FFFF	Bitfield indicates state of 16 alarm output flags; 0 = released, 1 = asserted Bit 0 = relay/setpoint output flag 1 Bit 1 = KYZ/setpoint output flag 2 Bit 2 = setpoint output flag 3 … Bit 15 = setpoint output flag 16
3	Status inputs state	0 to 3	Bit 0 = status input 1; 0 = open, 1 = contact closure detected Bit 1 = status input 2; 0 = open, 1 = contact closure detected Bit 2 = demand sync timeout; 1 = the demand delay expired before the next expected external demand sync. This bit clears when the next external demand sync occurs. Refer to Table A.6 Advanced Device Configuration element 23. Bits 3-15 = unused (always 0)
4	Status input #1 counter	0 to 29,999	Counts to 29,999, rolls over to 0.
5	Status input #2 counter		

TIP Size and content of Instance 1 may vary depending on user configuration. Refer to User-Configured Data Table on page 4-53 for more information

DeviceNet, EtherNet/IP and ControlNet I/O Data Accepted by Powermonitor (Scanner Output Data; Instance 2)

Element No.	Element name	Range	Default Value	Comment
0	Relay output	0 to 1	-	0 (Bit 8 = 0): De-energize 256 (Bit 8 = 1): Energize Must be enabled by *Control source* parameter
1	Solid-state KYZ output	0 to 1		

Table A.3 Discrete Data

CSP File No.	N9
Remote I/O BT	10
CIP Assy. Inst.	3
No. of Elements	6
User Configurable	No
Data Type	Integer
Data Access	Read Only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Comment
0	30001	Relay output status	0 to 3	0 = De-energized & not forced 1 = Energized & not forced 2 = Force De-energized 3 = Force Energized
1	30002	Solid-state KYZ output status		
2	30003	Alarm output word	0 to FFFF	Bitfield indicating state of the 16 alarm output flags; 0 = released, 1 = asserted. Bit 0 = relay/setpoint output flag 1 Bit 1 = KYZ/setpoint output flag 2 Bit 2 = setpoint output flag 3 … Bit 15 = setpoint output flag 16
3	30004	Status inputs state	0 to 3	Bit 0 = status input #1; 0 = open, 1 = contact closure detected Bit 1 = status input #2; 0 = open, 1 = contact closure detected Bit 2 = demand sync timeout; 1 = the demand delay expired before the next expected external demand sync. This bit clears when the next external demand sync occurs. Refer to Table A.6 Advanced Device Configuration element 23. Bits 3-15 = unused (always 0)
4	30005	Status input #1 counter	0 to 29999	Counts to 29,999,rolls over to 0
5	30006	Status input #2 counter		

Table A.4 Basic Device Configuration

CSP File No.	F10
Remote I/O BT	20
CIP Assy. Inst.	4 (Write), 5 (Read)
No. of Elements	8 (M4, M5), 9 (M6, M8)
User Configurable	No
Data Type	Floating point
Data Access	Read / Write
PM3000 Type	See table

Element No.	Modbus Address	Element name	M4 M5	M6	M8	Range	Units	Default Value	Comment
0	40001-2	Password	•	•	•	0 to 9999	-	0	Valid password required to change configuration. Returns -1
1	40003-4	Wiring mode	•	•	•	0 to 8	-	6	0 = Delta 3 CT 1 = Delta 2 CT 2 = Direct Delta 3 CT 3 = Direct Delta 2 CT 4 = Open Delta 3 CT 5 = Open Delta 2 CT 6 = Wye 7 = Single Phase 8 = Demo
2	40005-6	Potential transformer (PT) primary	•	•	•	1.0 to 10,000,000.0	Volts	480.0	The high side of the PT ratio (**xxx**:xxx)
3	40007-8	PT secondary	•	•	•	1.0 to 600.0	Volts	480.0	The low side of the PT ratio (xxx:**xxx**)
4	40009-10	I1/I2/I3 current transformer (CT) Primary	•	•	•	1.0 to 10,000,000.0	Amps	5.0	The high side of the CT ratio (**xxx**:xxx)
5	40011-12	I1/I2/I3 CT secondary	•	•	•	1.0 to 5.0	Amps	5.0	The low side of the CT ratio (xxx:**xxx**)
6	40013-14	I4 CT primary	•	•	•	1.0 to 10,000,000.0	Amps	5.0	The high side of the I4 CT ratio (**xxx**:xxx)
7	40015-16	I4 CT secondary	•	•	•	1.0 to 5.0	Amps	5.0	The low side of the I4 CT ratio (xxx:**xxx**)
8	40017-18	Nominal system voltage		•	•	1.0 to 10,000,000.0	Volts	480.0	Value is used in the default Sag and Swell setpoints. (M6 and M8 only)

Table A.5 Date and Time

CSP File No.	N11
Remote I/O BT	12
CIP Assy. Inst.	6 (Write), 7 (Read)
No. of Elements	8
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Default Value[2]	Comment
0	40101	Password	0 to 9999	0	Valid password required to change the date & time. Returns -1
1	40102	Date: year	1998 to 2097	1998	1 = January, 2 = February,…12 = December The internal clock adjusts the date for leap year.
2	40103	Date: month	1 to 12	1	
3	40104	Date: day	1 to 31[1]	1	
4	40105	Time: hour	0 to 23	0	0 = 12am, 1 = 1am,…23 = 11pm The internal clock does not adjust for daylight savings time.
5	40106	Time: minute	0 to 59	0	
6	40107	Time: seconds	0 to 59	0	
7	40108	Time: hundredths of seconds	0 to 99	0	

(1) On a write, the maximum value for "day" depends on the values written to "month" and the "year".

(2) The data and time default values are set if one of the following three conditions occur:
- When the device is first powered-up at the factory
- A device power-up following the depletion of the real-time clock power source
- In the event of an abnormal condition which may cause the real-time clock to contain values which are not in the valid range

The date and time are not set to the default values when "Restore Factory Defaults" is performed via the Display Module or communications port.

Table A.6 Advanced Device Configuration

CSP File No.	N12
Remote I/O BT	26
CIP Assy. Inst.	8 (Write), 9 (Read)
No. of Elements	25
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40201	Password	0 to 9999	-	0	Required to change configuration data. Returns -1
1	40202	New password	0 to 9999	-	-1	-1 = no action; 0 to 9999 = new password; returns -1
2	40203	Demand period length	-99 to +99	Min	15	Refer to Demand Calculation on page 3-9
3	40204	Number of demand periods	1 to 15	-	1	
4	40205	Predicted demand type	0 to 2	-	0	0 = instantaneous; 1 = 1st order; 2 = 2nd order
5	40206	KYZ control source	0 to 8	-	7	0 = None (forcing only) 1 = Wh Forward 2 = Wh Reverse 3 = VARh Forward 4 = VARh Reverse 5 = Vah 6 = Ah 7 = Setpoints 8 = Discrete control (RIO, DeviceNet)
6	40207	KYZ pulse output scale	1 to 30000	-	10	Refer to Relay and KYZ Output Operations on page 6-1
7	40208	KYZ pulse output width	0, 40 to 2000	mSec	0	0 = KYZ-style transition 40 to 2000 = pulse duration
8	40209	Relay control source	0 to 8	-	7	Same choices as *KYZ control source*
9	40210	Relay pulse output scale	1 to 30000	-	10	Refer to Relay and KYZ Output Operations on page 6-1
10	40211	Relay pulse output width	0, 40 to 2000	mSec	100	0 = KYZ-style transition 40 to 2000 = pulse duration
11	40212	RMS resolution	0 to 1	-	0 (M4) 1 (M5, 6 or 8)	0 = Nominal 1 = High
12	40213	RMS result averaging	0 to 1	-	0 (M4) 1 (M5, 6 or 8)	0 = No averaging. 1 = Average of the last 8 results
13	40214	Frequency averaging	0 to 1	-	1	0 = none; 1 = last 8 cycles
14	40215	Restore factory default config	0 to 1	-	0	0 = No action 1 = Restore factory default settings
15	40216	Clear status input counters	0 to 3	-	0	0 = No action 1 = Clear counter #1 2 = Clear counter #2 3 = Clear both
16	40217	Wdog action	0 to 1	-	1	0 = Restart, log an event and halt operation 1 = Restart, log an event and resume Refer to Watchdog Timeout Action on page 3-28.

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
17	40218	Force relay output	0 to 3	-	0	0 = No change 1 = Force energize the relay 2 = Force de-energize the relay 3 = Release force of relay output Overrides setpoint or pulse output control
18	40219	Force solid-state KYZ output	0 to 3	-	0	
19	40220	Default relay state in event of communications loss	0 to 3	-	0	0 = Last state / resume 1 = Last state / freeze 2 = De-energize / resume 3 = De-energize / freeze Refer to Communications Loss Behavior on page 6-4
20	40221	Default KYZ state in event of communications loss				
21	40222	DM text scroll rate	0 to 1	-	1	0 = Slow; 1 = Fast
22	40223	Energy counter rollover	4 to 15	Digits	15	Refer to Configurable Energy Counter Rollover on page 3-9
23	40224	Forced demand sync delay	0 to 900	Seconds	10	0 = Disable, 1 to 900 = number of seconds delay
24	40225	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0.
25	40226	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0.

Table A.7 Native Communication Configuration

CSP File No.	N13
Remote I/O BT	11
CIP Assy. Inst.	10 (Write), 11 (Read)
No. of Elements	6
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40301	Password	0 to 9999	-	0	Valid password required to change configuration data. Returns -1
1	40302	Protocol	0	-	0	0 = DF1 half-duplex slave 1 = Modbus RTU slave 2 = Auto Sense - Selects the protocol based on the incoming communication packets
2	40303	Delay	0 to 15	5 mS	2 (10mS)	Specifies the delay before responding to an external request, useful with slow external devices (such as RF modems).
3	40304	Baud rate	0 to 4	-	3	0 = 1200 baud 1 = 2400 baud 2 = 4800 baud 3 = 9600 baud 4 = 19200 baud

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
4	40305	Device address	1 to 247	-	(1)	Identifies the device on a multi-drop network. 0 is typically used by the DF1 master. 255 is the broadcast address
5	40306	Data format	0 to 2	-	0	Parity, number of data bits, number of stop bits 0 = No parity, 8 data bits, 1 stop bit 1 = Odd parity, 8 data bits, 1 stop bit 2 = Even parity, 8 data bits, 1 stop bit
6	40307	Inter-Character Timeout	0 to 6553	mS	0	Specifies the minimum delay between characters that indicates the end of a message packet. 0 = 3.5 character times.

(1) The default address is the 'Device ID', which is factory assigned and is found on the label on the side of the master module. The device ID is incremented for each device.

Table A.8 Optional Communication Configuration

CSP File No.	N14
Remote I/O BT	24
CIP Assy. Inst.	12 (Write), 13 (Read)
No. of Elements	20
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

TIP Select the table that applies to your Powermontior 3000.

Ethernet

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40401	Password	0 to 9999	-	0	Valid password required to change configuration data. Returns -1
1	40402	IP address byte a	0 to 255	-	128	Format: aaa.bbb.ccc.ddd. Static IP address of this device (for example 130.151.32.86). Address 0.0.0.0 enables bootp server to assign IP address, subnet mask and gateway. If connected to a network, IP address must be unique. (255.255.255.255 is not permitted.)
2	40403	IP address byte b			1	
3	40404	IP address byte c			1	
4	40405	IP address byte d			Device ID	Factory-assigned device ID
5	40406	Subnet mask byte a	0 to 255	-	255	Format aaa.bbb.ccc.ddd. Ignored if bootp enabled.
6	40407	Subnet mask byte b			255	
7	40408	Subnet mask byte c			255	
8	40409	Subnet mask byte d			0	
9	40410	Gateway IP address byte a	0 to 255	-	128	IP address of the gateway on this subnet used to route messages to other subnets (wide area networking). Ignored if bootp enabled.
10	40411	Gateway IP address byte b			1	
11	40412	Gateway IP address byte c			1	
12	40413	Gateway IP address byte d			1	
13	40414	Keep Alive Time (ENT Series A) Reserved (ENT Series B)	0 to 3600	Seconds	30	The maximum time a socket is dedicated to a connection that is not responding. Reserved on Series B. Must be 0 on a write, returns 0

Ethernet

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
14	40415	Protocol select (ENT Series A) Reserved (ENT Series B)	0	-	0 to 2	When master module firmware > = V1.12 & Ethernet firmware > = V2.01, 0 = CSP/CIP (concurrent support for both protocols) 1 = CSP protocol 2 = CIP protocol When master module firmware <V1.12 & Ethernet firmware <V2.01, protocol supported is CSP and this parameter is reserved (write a 0, always reads 0). Reserved on Series B. Must be 0 on a write, returns 0
15	40416	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0
16	40417					
17	40418					
18	40419					
19	40420					

ControlNet

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40401	Password	0 to 9999	-	0	Valid password required to change configuration data. Returns -1
1	40402	MAC ID	0 to 99	-	99	On a write, sets MAC ID (node address) of Powermonitor 3000 on ControlNet network.
2	40403	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0
3	40404					
4	40405					
5	40406					
6	40407					
7	40408					
8	40409					
9	40410					
10	40411					
11	40412					
12	40413					
13	40414					
14	40415					
15	40416					
16	40417					
17	40418					
18	40419					
19	40420					

Remote I/O

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40401	Password	0 to 9999	0	Valid password required to change configuration data. Returns -1
1	40402	Logical rack address	1 to 63	1	The scanner uses rack address 0
2	40403	Module group	0,2,4,6	0	0 = Group 0 (acts like the first 2 rack slots) 2 = Group 2 4 = Group 4 6 = Group 6
3	40404	Last rack	0 to 1	0	0 = No 1 = Yes
4	40405	Baud rate	0 to 2	0	0 = 57.6k baud 1 = 115.2k baud 2 = 230.4k baud
5	40406	Reserved	0	0	Reserved. Must be 0 on a write, returns 0
6	40407				
7	40408				
8	40409				
9	40410				
10	40411				
11	40412				
12	40413				
13	40414				
14	40415				
15	40416				
16	40417				
17	40418				
18	40419				
19	40420				

DeviceNet

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40401	Password	0 to 9999	0	Valid password required to change configuration data. Returns -1
1	40402	Node address (MAC ID)	0 to 64	63	Address 64 enables remote node address programming; there is no actual node address of 64 defined for DeviceNet.
2	40403	Baud rate	0 to 4	0	0 = 125k 1 = 250k 2 = 500k 3 = Auto 4 = Programmable
3	40404	Bus Off Interrupt Action	0 to 1	0	0 = hold CAN chip in reset 1 = reset CAN chip and continue communications
4	40405	Reserved	0	0	Reserved. Must be 0 on a write, returns 0
5	40406				
6	40407				
7	40408				
8	40409				
9	40410				
10	40411				
11	40412				
12	40413				
13	40414				
14	40415				
15	40416				
16	40417				
17	40418				
18	40419				
19	40420				

RS-232

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40401	Password	0 to 9999	0	Required to change configuration data. Returns -1
1	40402	Hardware port	0 to 1	0	Select active port 0 = RS-232 port 1 = Native RS-485 port
2	40403	Protocol	0	0	0 = DF1 half-duplex slave
3	40404	Delay	0 to 15	2 (10mS)	Specifies the delay before responding to an external request., useful with slow external devices (such as RF modems)
4	40405	Baud rate	0 to 4	3	0 = 1200 baud 1 = 2400 baud 2 = 4800 baud 3 = 9600 baud 4 = 19200 baud
5	40406	RS-232 address	1 to 254	(1)	Identifies the device on the link. 0 is typically used by the DF1 master. 255 is the broadcast address
6	40407	Data format	0 to 2	0	Parity, number of data bits, number of stop bits 0 = No parity, 8 data bits, 1 stop bit 1 = Even parity, 8 data bits, 1 stop bit 2 = Odd parity, 8 data bits, 1 stop bit
7	40408	Flow Control (Handshaking)	0 to 1	0	Data flow control for RS-232/RS-485 port. 0 = None 1 = Hardware RTS/CTS
8	40409	RTS On Delay	0 to 9995 ms	0	
9	40410				
10	40411				Specifies the minimum delay between characters that indicates the end of a message packet. 0 = 3.5 character times.
11	40412	Reserved	0	0	Reserved. Must be 0 on a write, returns 0
12	40413				
13	40414				
14	40415				
15	40416				
16	40417				
17	40418				
18	40419				
19	40420				

(1) The default address is the same as the 'Device ID', which is assigned at the factory and can be found printed on the white label on the side of the master module. The device ID is incremented for each device.

Table A.9 Metering Voltage, Current and Frequency Result

CSP File No.	F15
Remote I/O BT	38
CIP Assy. Inst.	14
No. of Elements	14
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30101-2	L1 Current	Amps (A)	0.0 to $999.9x10^{21}$	Refer to Voltage, Current and Frequency Results on page 3-4.
1	30103-4	L2 Current		0.0 to $999.9x10^{21}$	
2	30105-6	L3 Current		0.0 to $999.9x10^{21}$	
3	30107-8	Avg. Current		0.0 to $999.9x10^{21}$	
4	30109-10	L1-N Voltage	Volts (V)	0.0 to $999.9x10^{21}$	
5	30111-12	L2-N Voltage		0.0 to $999.9x10^{21}$	
6	30113-14	L3-N Voltage		0.0 to $999.9x10^{21}$	
7	30115-16	Avg. L-N Voltage		0.0 to $999.9x10^{21}$	
8	30117-18	L1-L2 Voltage		0.0 to $999.9x10^{21}$	
9	30119-20	L2-L3 Voltage		0.0 to $999.9x10^{21}$	
10	30121-22	L3-L1 Voltage		0.0 to $999.9x10^{21}$	
11	30123-24	Avg L-L Voltage		0.0 to $999.9x10^{21}$	
12	30125-26	Frequency, last cycle	Hertz (Hz)	40.0 to 75.0	Returns 0 or 999.0 if out of range
13	30127-28	Metering iteration	-	0 to 32767	Increments by 1 to 32767, rolls over to 0

Table A.10 Metering Sequence Voltage and Current Results

CSP File No.	F16
Remote I/O BT	27
CIP Assy. Inst.	15
No. of Elements	11
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30201-02	L4 (Zero sequence) Current	Amps (A)	0.0 to $999.9x10^{21}$	Refer to Symmetrical Component Analysis Results on page 3-5.
1	30203-04	Positive Sequence Current		0.0 to $999.9x10^{21}$	
2	30205-06	Negative Sequence Current		0.0 to $999.9x10^{21}$	
3	30207-08	% Current unbalance	Per Cent	0.0 to 100.0	
4	30209-10	Positive Sequence Voltage	Volts (V)	0.0 to $999.9x10^{21}$	
5	30211-12	Negative Sequence Voltage		0.0 to $999.9x10^{21}$	
6	30213-14	% Voltage unbalance	Per Cent	0.0 to 100.0	
7	30215-16	Phase rotation	-	0 to 2	0 = No rotation 1 = ABC rotation 2 = ACB rotation
8	30217-18	Average frequency	Hertz (Hz)	40.0 to 75.0	Average of the last 1 or 8 cycles. Returns 0 or 999.0 if out of range
9	30219-20	Frequency source	-	0 to 2	0 = V1, 1 = V2, 2 = V3
10	30221-22	Metering iteration	-	0 to 32767	Increments by 1 to 32767, rolls over to 0

Table A.11 Metering Power Results

CSP File No.	F17
Remote I/O BT	31
CIP Assy. Inst.	16
No. of Elements	13
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30301-02	L1 Real Power	Watts (W)	0.0 to $999.9x10^{22}$	Real power per phase, signed to show direction. Refer to Power Results on page 3-6.
1	30303-04	L2 Real Power		0.0 to $999.9x10^{22}$	
2	30305-06	L3 Real Power		0.0 to $999.9x10^{22}$	
3	30307-08	Total Real Power		0.0 to $999.9x10^{22}$	Total power signed to show direction.
4	30309-10	L1 Reactive Power	Volt-amps reactive (VAR)	0.0 to $999.9x10^{22}$	Reactive power per phase, signed to show direction.
5	30311-12	L2 Reactive Power		0.0 to $999.9x10^{22}$	
6	30313-14	L3 Reactive Power		0.0 to $999.9x10^{22}$	
7	30315-16	Total Reactive Power		0.0 to $999.9x10^{22}$	Total reactive power, signed to show direction.
8	30317-18	L1 Apparent Power	Volt-amps (VA)	0.0 to $999.9x10^{22}$	Apparent power per phase.
9	30319-20	L2 Apparent Power		0.0 to $999.9x10^{22}$	
10	30321-22	L3 Apparent Power		0.0 to $999.9x10^{22}$	
11	30323-24	Total Apparent Power		0.0 to $999.9x10^{22}$	Total apparent power
12	30325-26	Metering iteration	-	0 to 32767	Increments by 1 to 32767, rolls over to 0

Table A.12 Metering Demand Results

CSP File No.	F18
Remote I/O BT	25
CIP Assy. Inst.	17
No. of Elements	10
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30401-02	Demand Current	Amps (A)	0.0 to $999.9x10^{21}$	Refer to Energy Results on page 3-8.
1	30403-04	Demand Power	Watts (W)	0.0 to $999.9x10^{21}$	
2	30405-06	Demand Reactive Power	VAR	0.0 to $999.9x10^{21}$	
3	30407-08	Demand Apparent Power	VA	0.0 to $999.9x10^{21}$	
4	30409-10	Projected Demand I	Amps	0.0 to $999.9x10^{21}$	Refer to Projected Demand Calculation on page 3-10.
5	30411-12	Projected Demand W	Watts	0.0 to $999.9x10^{21}$	
6	30413-14	Projected Demand VAR	VAR	0.0 to $999.9x10^{21}$	
7	30415-16	Projected Demand VA	VA	0.0 to $999.9x10^{21}$	
8	30417-18	Elapsed demand period time	Minutes	0.0 to $999.9x10^{21}$	The time elapsed within the current demand period.
9	30419-20	Metering iteration	-	0 to 32767	Increments by 1 to 32767, rolls over to 0

Table A.13 Metering Power Factor Results

CSP File No.	F19
Remote I/O BT	33
CIP Assy. Inst.	18
No. of Elements	13
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30501-02	L1 True Power Factor	Percent	-100 to 100	Ratio between power and apparent power. + = Lead - = Lag
1	30503-04	L2 True Power Factor		-100 to 100	
2	30505-06	L3 True Power Factor		-100 to 100	
3	30507-08	3-phase True PF		-100 to 100	
4	30509-10	L1 Displacement Power Factor		-100 to 100	Cosine of the phase angle between the fundamental voltage and current. + = Lead - = Lag
5	30511-12	L2 Displacement Power Factor		-100 to 100	
6	30513-14	L3 Displacement Power Factor		-100 to 100	
7	30515-16	3-phase Displacement PF		-100 to 100	
8	30517-18	L1 Distortion Power Factor		0 to 100	The ratio between the magnitude of the fundamental and the sum of the magnitudes for all of the current harmonics.
9	30519-20	L2 Distortion Power Factor		0 to 100	
10	30521-22	L3 Distortion Power Factor		0 to 100	
11	30523-24	3-phase Distortion PF		0 to 100	
12	30525-26	Metering iteration	-	0 to 32767	Increments by 1 to 32767, rolls over to 0

Table A.14 Metering Real and Apparent Energy Results

CSP File No.	N20
Remote I/O BT	29
CIP Assy. Inst.	19 (Write), 20 (Read)
No. of Elements	23
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element Name	Range	Units	Default Value	Comment
0	40501	Password	0 to 9999	-	0	Required to clear or preset energy counters. Returns -1.
1	40502	Parameter select	0 to 7 (bitfield)	-		Refer to How to Clear or Preset Energy Counters Using Communications on page 4-52.
2	40503	KWh forward ### x 10^9	-999 to 999	kWh		
3	40504	### x 10^6				
4	40505	### x 10^3				
5	40506	### x 10^0				
6	40507	### x 10^{-3}				
7	40508	KWh reverse ### x 10^9	-999 to 999			
8	40509	### x 10^6				
9	40510	### x 10^3				
10	40511	### x 10^0				
11	40512	### x 10^{-3}				
12	40513	Kwh net ### x 10^9	-999 to 999			
13	40514	### x 10^6				
14	40515	### x 10^3				
15	40516	### x 10^0				
16	40517	### x 10^{-3}				
17	40518	KVAh ### x 10^9	-999 to 999	KVAh		
18	40519	### x 10^6				
19	40520	### x 10^3				
20	40521	### x 10^0				
21	40522	### x 10^{-3}				
22	40523	Metering iteration	0 to 32767	-		Increments by 1 to 32767, rolls over to 0

Table A.15 Metering Reactive Energy and Amp-Hour Results

CSP File No.	N21
Remote I/O BT	30
CIP Assy. Inst.	21 (Write), 22 (Read)
No. of Elements	23
User Configurable	No
Data Type	Integer
Data Access	Read/Write
PM3000 Type	All

Element No.	Modbus Address	Element name		Range	Units	Default Value	Comment
0	40601	Password		0 to 9999	-	0	Required to clear or preset energy counters. Returns -1.
1	40602	Parameter select		0 to 7	-		Refer to How to Clear or Preset Energy Counters Using Communications on page 4-52.
2	40603	KVARh forward	### x 10^9	-999 to 999	kVARh		
3	40604		### x 10^6				
4	40605		### x 10^3				
5	40606		### x 10^0				
6	40607		### x 10^{-3}				
7	40608	KVARh reverse	### x 10^9	-999 to 999			
8	40609		### x 10^6				
9	40610		### x 10^3				
10	40611		### x 10^0				
11	40612		### x 10^{-3}				
12	40613	KVARh net	### x 10^9	-999 to 999			
13	40614		### x 10^6				
14	40615		### x 10^3				
15	40616		### x 10^0				
16	40617		### x 10^{-3}				
17	40618	KAh	### x 10^9	-999 to 999	kAh		
18	40619		### x 10^6				
19	40620		### x 10^3				
20	40621		### x 10^0				
21	40622		### x 10^{-3}				
22	40623	Metering iteration		0 to 32767	-		Increments by 1 to 32767, rolls over to 0

Table A.16 Selftest/Diagnostic Results

CSP File No.	N22
Remote I/O BT	36
CIP Assy. Inst.	23
No. of Elements	27
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Comment
0	30601	Bulletin number	1404	
1	30602	Series	0 to 8	0 = A, 1 = B, etc.
2	30603	Overall status	-	0 = OK
3	30604	Data Acquisition status	-	0 = OK bit 0 = overall status; 0 = pass, 1 = fail bit 1 = reserved bit 2 = data bus connection failure bit 3 = address test failure
4	30605	Data FLASH status	-	0 = OK
5	30606	Real-time clock status	-	0 = OK
6	30607	RTC NVRAM status	-	0 = OK Non-zero indicates corruption of non-volatile memory. This does not cause product to shutdown. The error is cleared on a reset/power cycle. If this error is detected, date/time, and energy values are reset.
7	30608	Option communications status	-	0 = OK or no optional communications present
8	30609	Display module status	-	0 = OK or no DM connected
9	30610	Watchdog status	-	0 = OK
10	30611	Code FLASH status	-	0 = OK bit 0 = overall status; 0 = pass, 1 = fail bit 1 = boot code checksum failure bit 2 = application code checksum failure bit 3 = calibration CRC failure bit 4 = no calibration data bit 5 = wrong application firmware loaded
11	30612	RAM status	-	0 = OK bit 0 = read/write test failure
12	30613	Application FRN	0 to 9999	100 indicates V1.00, 103 indicates V1.03, etc.
13	30614	Boot code FRN	0 to 9999	100 indicates V1.00, 101 indicates V1.01, etc.
14	30615	ASIC build #	0 to 9999	Revision number of the 'code' which was used to fabricate the ASIC.
15	30616	Option communications FRN	0 to 9999	100 indicates V1.00, 103 indicates V1.03, etc. 0 = none (catalog numbers ending in -000, -232)
16	30617	Display module FRN	0 to 9999	104 indicates V 1.04, 105 indicates V1.05, etc. Returns 0 if no DM connected
17	30618	Reserved	0	Returns 0

Element No.	Modbus Address	Element name	Range	Comment
18	30619	Digital board revision	0 to 7	0 = 02A, 1 = 03A, etc.
19	30620	Analog board revision	0 to 7	0 = 02A, 1 = 03A, etc.
20	30621	Reserved	0	Returns 0
21	30622	Reserved	0	Returns 0
22	30623	MM Device ID	0 to 255	Sequentially assigned at time of manufacture. May not be changed.
23	30624	Master Module type, current	4,5,6,or 8	4 = M4, 5 = M5, 6 = M6, 8 = M8; reflects any upgrades
24	30625	Display module type	0 to 1	0 = No display module connected 1 = 1404-DM connected to master module
25	30626	Option communications type	-	00 = No optional communications (native RS-485 only) 81 = DeviceNet V1 82 = ControlNet 84 = Remote I/O 85 = Ethernet Series A 86 = RS-232 88 = DeviceNet V2 89 = IEC870 comm card 90 = Ethernet Series B
26	30627	Accuracy Class	0 to 2	Indicates revenue metering accuracy class as manufactured (refer to page 3-3). 0 = Class 1 1 = Class 0.5 2 = Class 0.2

TIP This is not truly a data table, but a reply to a PCCC diagnostic status request (used by RSWho to display text and an icon for the Powermonitor 3000). This data is not accessible using Modbus.

Table A.17 DF1 PCCC Diagnostic Status Reply

Byte	Bits	Contents	Description
1	0-1	Mode/status	Unused
	2-3		
	4-7		
2	0-7	Type extender	EE
3	0-7	Extended interface type	36h = DF1 half-duplex slave (via native RS485 port or RS-232 port) 65h = Ethernet
4	0-7	Extended processor type	8Ah; 1404 Powermonitor 3000 products
5	0-4	Series/revision	Unused
	5-7		
6-16	All	Catalog number (in ASCII)	Catalog number written into the device at time of production or calibration. For example '1404-M4-05-A-RIO'
17-24	All	Product Specific	Unused

Table A.18 Setpoint Setup/Read-Back Select and Status

CSP File No.	N23
Remote I/O BT	22
CIP Assy. Inst.	24 (Write), 25 (Read)
No. of Elements	16
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40701	Password	0 to 9999	-	0	Required for configuration, -1 for readback select, returns -1.
1	40702	Setpoint number	1 to 10 (M4, M5) 1 to 20 (M6, M8)	-	-	Refer to Writing Setpoint Configuration Using Communications on page 5-11.
2	40703	Read-back mode	0 to 1	-	0	
3	40704	Setpoint type	0 to 52	-	0(1)	
4	40705	Evaluation condition	0 to 5	-	0	
5	40706	High limit Integer	0 to 9999	Depends on setpoint type	0(1)	
6	40707	High limit Exponent	-4 to 21		0(1)	
7	40708	Low limit Integer	0 to 9999		0(1)	
8	40709	Low Limit Exponent	-4 to 21		0(1)	
9	40710	Action delay	0-3600 (M4, M5) 0-30000 (M6, M8)	Seconds (M4, M5) .1 Sec (M6, M8)	0	
10	40711	Release delay	0-3600 (M4, M5) 0-30000 (M6, M8)	Seconds (M4, M5) .1 Sec (M6, M8)	0	
11	40712	Output action	0 to 32 (M4, M5) 0 to 43 (M6, M8)	-	0(1)	
12	40713	Status	0 to 1	-	0	
13	40714	Accumulated time Integer	0 to 9999	Seconds	-	
14	40415	Accumulated time Exponent	-1 to 21	-	-	
15	40716	Clear time accumulator command	0 to 1	-	0	

(1) On the M6 and M8, setpoint #19 and #20 default to detect voltage sag and voltage swell. See Sag and Swell, page 8-13

Table A.19 List of Setpoint Types

Applies to:	Refer to Table A.18 Setpoint Setup/Read-Back Select and Status
PM3000 Type	See table

Param. No.	Parameter name	M4 M5	M 6	M 8	Comment
0	Not used	•	•	•	Disables the setpoint.
1	Voltage(1)	•	•	•	Refer to Table A.9 Metering Voltage, Current and Frequency Result
2	Current(1)	•	•	•	
3	Voltage unbalance	•	•	•	Refer to Table A.10 Metering Sequence Voltage and Current Results
4	Current unbalance	•	•	•	
5	Neutral current	•	•	•	
6	W	•	•	•	Refer to Table A.11 Metering Power Results
7	VAR	•	•	•	
8	VA	•	•	•	
9	Total true PF	•	•	•	Refer to Table A.13 Metering Power Factor Results
10	Total disp PF	•	•	•	
11	Total dist PF	•	•	•	
12	W demand	•	•	•	Refer to Table A.12 Metering Demand Results
13	VAR demand	•	•	•	
14	VA demand	•	•	•	
15	Amp demand	•	•	•	
16	Projected amp demand	•	•	•	
17	Projected W Demand	•	•	•	
18	Projected VAR Demand	•	•	•	
19	Projected VA Demand	•	•	•	
20	Frequency	•	•	•	Refer to Table A.9 Metering Voltage, Current and Frequency Result
21	Phase rotation	•	•	•	Refer to Table A.10 Metering Sequence Voltage and Current Results
22	Crest factor voltage	•	•	•	Refer to Table A.34 Harmonic Results; THD, Crest Factor, and More
23	Crest factor current	•	•	•	
24	Crest factor I4	•	•	•	
25	IEEE THD voltage(1)	•	•	•	
26	IEEE THD current(1)	•	•	•	
27	IEEE THD I4	•	•	•	
28	IEC THD voltage(1)	•	•	•	
29	IEC THD current(1)	•	•	•	
30	IEC THD I4	•	•	•	
31	Status input 1	•	•	•	Refer to Table A.3 Discrete Data
32	Status input 2	•	•	•	
33	Any status input(1)	•	•	•	

Param. No.	Parameter name	M4 M5	M 6	M 8	Comment
34	Setpoint #1 time accumulator	•	•	•	Refer to Table A.20 Setpoint Output Actions
35	Setpoint #2 time accumulator	•	•	•	
36	Setpoint #3 time accumulator	•	•	•	
37	Setpoint #4 time accumulator	•	•	•	
38	Setpoint #5 time accumulator	•	•	•	
39	Setpoint #6 time accumulator	•	•	•	
40	Setpoint #7 time accumulator	•	•	•	
41	Setpoint #8 time accumulator	•	•	•	
42	Setpoint #9 time accumulator	•	•	•	
43	Setpoint #10 time accumulator	•	•	•	
44	Voltage Sag(2)		•	•	Refer to Sag and Swell on page 8-13
45	Voltage Swell(2)		•	•	
46	Transient detected(2)			•	Triggers a setpoint when a transient has been detected
47	Avg IEEE THD V	•	•	•	Refer to Table A.34 Harmonic Results; THD, Crest Factor, and More .
48	Avg IEEE THD I	•	•	•	
49	Avg IEC thd V	•	•	•	
50	Avg IEC thd I	•	•	•	
51	Avg Crest Factor V	•	•	•	
52	Avg Crest Factor I	•	•	•	

(1) A setpoint activates when the magnitude of any phase passes the activation limit and releases when all phases pass the release limit in the appropriate direction for the setpoint evaluation condition.

(2) These setpoint types apply only to the applicable Powermonitor 3000 models and will appear as “inactive” on other models.

Table A.20 Setpoint Output Actions

Applies to:	Refer to Setpoint Setup/Read-Back Select and Status on page A-26
PM3000 Type	See table

Param. #	Parameter name	M4 M5	M 6	M 8	Comment
0	None	•	•	•	No output action, but recorded in the event log and *Setpoint status* recorded.
1	Energize relay and set alarm flag 1	•	•	•	Refer to Table A.3 Discrete Data .
2	Energize KYZ and set alarm flag 2	•	•	•	
3	Set alarm flag 3	•	•	•	
4	Set alarm flag 4	•	•	•	
5	Set alarm flag 5	•	•	•	
6	Set alarm flag 6	•	•	•	
7	Set alarm flag 7	•	•	•	
8	Set alarm flag 8	•	•	•	
9	Set alarm flag 9	•	•	•	
10	Set alarm flag 10	•	•	•	
11	Set alarm flag 11	•	•	•	
12	Set alarm flag 12	•	•	•	
13	Set alarm flag 13	•	•	•	
14	Set alarm flag 14	•	•	•	
15	Set alarm flag 15	•	•	•	
16	Set alarm flag 16	•	•	•	
17	Save a trend log record	•	•	•	Saves record even if periodic trending is disabled
18	Clear kWh result	•	•	•	
19	Clear kVARh result	•	•	•	
20	Clear kVAh result	•	•	•	
21	Clear Ah result	•	•	•	
22	Clear all energy results	•	•	•	

Param. #	Parameter name	M4 M5	M 6	M 8	Comment
23	Clear setpoint #1 time	•	•	•	Clears the corresponding setpoint time accumulator
24	Clear setpoint #2 time	•	•	•	
25	Clear setpoint #3 time	•	•	•	
26	Clear setpoint #4 time	•	•	•	
27	Clear setpoint #5 time	•	•	•	
28	Clear setpoint #6 time	•	•	•	
29	Clear setpoint #7 time	•	•	•	
30	Clear setpoint #8 time	•	•	•	
31	Clear setpoint #9 time	•	•	•	
32	Clear setpoint #10 time	•	•	•	
33	Clear setpoint #11 time		•	•	
34	Clear setpoint #12 time		•	•	
35	Clear setpoint #13 time		•	•	
36	Clear setpoint #14 time		•	•	
37	Clear setpoint #15 time		•	•	
38	Clear setpoint #16 time		•	•	
39	Clear setpoint #17 time		•	•	
40	Clear setpoint #18 time		•	•	
41	Clear setpoint #19 time		•	•	
42	Clear setpoint #20 time		•	•	
43	Capture oscillograph		•	•	Triggers a capture per the current oscillography configuration

Table A.21 Trend Log Configuration/Read-Back Record Select

CSP File No.	N24
Remote I/O BT	34
CIP Assy. Inst.	26 (Write), 27 (Read)
No. of Elements	26
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40801	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	40802	DeviceNet unique write identifier	-32768 to 32767	0	Refer to DeviceNet Unique Write Identifier on page 4-36.
2	40803	Reserved	0	0	Must be 0 on a write; returns 0
3	40804	Read-back mode	0 to 6	2	Refer to Setting up the Trend Log on page 7-11, and Reading Data from the Trend Log on page 7-12.
4	40805	Logging interval	-1 to 3600	900 (15 min)	Expressed in seconds -1 = synchronize logging with demand interval 0 = disable periodic logging
5	40806	Logging mode	0 to 1	0	0 = Overwrite 1 = Fill and hold
6	40807	Clear trend log command	0 to 1	0	0 = no action 1 = clear trend log; returns 0
7	40808	Total records logged x 1000	0 to 999	-	Number of records = element 7 x 1000 + element 8
8	40809	Total records logged x 1	0 to 999	-	
9	40810	Reserved	0	-	Must be 0 on a write; returns 0
10	40811	Parameter #1 selection	1 to 301	122	Refer to Setting up the Trend Log on page 7-11. Defaults: Parameter 1: 122, Net Kilowatt-hours Parameter 2: 126, Net kVAR-hours Parameter 3: 100, Demand watts
11	40812	Parameter #2 selection	0 to 301	126	
12	40813	Parameter #3 selection		100	
13	40814	Parameter #4 selection		0	
14	40815	Parameter #5 selection			
15	40816	Parameter #6 selection			
16	40817	Parameter #7 selection			
17	40818	Parameter #8 selection			
18	40819	Parameter #9 selection(1)	0 to 301	0	
19	40820	Parameter #10 selection			
20	40821	Parameter #11 selection			
21	40822	Parameter #12 selection			
22	40823	Parameter #13 selection			
23	40824	Parameter #14 selection			
24	40825	Parameter #15 selection			
25	40826	Parameter #16 selection			

(1) For DeviceNet Powermonitors you may configure parameters 9 through 16 but Table A.22 will return only the first 8 parameters.

Table A.22 Trend Log Results

CSP File No.	F25
Remote I/O BT	48
CIP Assy. Inst.	28
No. of Elements	14 (DeviceNet only), 22 (All other communications types)
User Configurable	Yes
Data Type	Floating Point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Comment
0	30701-02	Reserved	0	Returns 0
1	30703-04	Internal Identifier	0 to 15	Increment from 1 to 15 for each record, rolls to 0
2	30705-06	Timestamp; Year	1998 to 2097	Date and time record was recorded. Refer to Expressing Data in Data Tables on page 4-18
3	30707-08	Month/Date	0101 to 1231	
4	30709-10	Hour/minute	0000 to 2359	
5	30711-12	Seconds/hsec	0000 to 5999	
6	30713-14	User selected parameter #1	-	The values of parameters that were configured.
7	30715-16	User selected parameter #2	-	
8	30717-18	User selected parameter #3	-	
9	30719-20	User selected parameter #4	-	
10	30721-22	User selected parameter #5	-	
11	30723-24	User selected parameter #6	-	
12	30725-26	User selected parameter #7	-	
13	30727-28	User selected parameter #8	-	
14	30729-30	User selected parameter #9	-	
15	30731-32	User selected parameter #10	-	
16	30733-34	User selected parameter #11	-	
17	30735-36	User selected parameter #12	-	
18	30737-38	User selected parameter #13	-	
19	30739-40	User selected parameter #14	-	
20	30741-42	User selected parameter #15	-	
21	30743-44	User selected parameter #16	-	

Table A.23 Min/Max Log Configuration/Read-Back Select

CSP File No.	N26
Remote I/O BT	13
CIP Assy. Inst.	29 (Write), 30 (Read)
No. of Elements	9
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40901	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	40902	Min/max parameter to read	0 to 73	1	Refer to Interfacing with the Min/Max Log Using Communications on page 7-14
2	40903	Read-back mode	0 to 1	0	
3	40904	Enable/disable Min/max log	0 to 1	1	
4	40905	Clear min/max log	0 to 1	0	
5	40906	Timestamp of last min/max clear; year	1998 to 2097	-	
6	40907	month/day	0101 to 1231	-	
7	40908	hour/minute	0000 to 2359	-	
8	40909	second/hsec	0000 to 5999	-	

Table A.24 Min/Max Log Parameter List

Applies to:	Table 23: Min/max log config. / read-back select Table 25: Min/max log results
PM3000 Type	All

Param No.	Parameter name	Comment
0	L1 Current	Refer to Table A.9 Metering Voltage, Current and Frequency Result
1	L2 Current	
2	L3 Current	
3	Avg Current	
4	L1-N Voltage	
5	L2-N Voltage	
6	L3-N Voltage	
7	Avg L-N Voltage	
8	L1-L2 Voltage	
9	L2-L3 Voltage	
10	L3-L1 Voltage	
11	Avg L-L Voltage	
12	Frequency, last cycle	
13	L4 Current	Refer to Table A.10 Metering Sequence Voltage and Current Results
14	Positive Sequence Current	
15	Negative Sequence Current	
16	% Current unbalance	
17	Positive Sequence Voltage	
18	Negative Sequence Voltage	
19	% Voltage unbalance	
20	Average frequency	
21	L1 Real Power	Refer to Table A.11 Metering Power Results
22	L2 Real Power	
23	L3 Real Power	
24	Total Real Power	
25	L1 Reactive Power	
26	L2 Reactive Power	
27	L3 Reactive Power	
28	Total Reactive Power	
29	L1 Apparent Power	
30	L2 Apparent Power	
31	L3 Apparent Power	
32	Total Apparent Power	

Param No.	Parameter name	Comment
33	Demand Current	Refer to Table A.12 Metering Demand Results
34	Demand Power	
35	Demand Reactive Power	
36	Demand Apparent Power	
37	Projected Demand I	
38	Projected Demand W	
39	Projected Demand VAR	
40	Projected Demand VA	
41	L1 True Power Factor	Refer to Table A.13 Metering Power Factor Results
42	L2 True Power Factor	
43	L3 True Power Factor	
44	3-phase True PF	
45	L1 Displacement Power Factor	
46	L2 Displacement Power Factor	
47	L3 Displacement Power Factor	
48	3-phase Displacement PF	Refer to Table A.13 Metering Power Factor Results
49	L1 Distortion Power Factor	
50	L2 Distortion Power Factor	
51	L3 Distortion Power Factor	
52	3-phase Distortion PF	
53	V1 % IEEE THD	Refer to Table A.34 Harmonic Results; THD, Crest Factor, and More
54	I1 % IEEE THD	
55	V2 % IEEE THD	
56	I2 % IEEE THD	
57	V3 % IEEE THD	
58	I3 % IEEE THD	
59	I4 % IEEE THD	
60	V1 % IEC thd (DIN)	
61	I1 % IEC thd (DIN)	
62	V2 % IEC thd (DIN)	
63	I2 % IEC thd (DIN)	
64	V3 % IEC thd (DIN)	
65	I3 % IEC thd (DIN)	
66	I4 % IEC thd (DIN)	
67	V1 Crest Factor	
68	I1 Crest Factor	
69	V2 Crest Factor	
70	I2 Crest Factor	
71	V3 Crest Factor	
72	I3 Crest Factor	
73	I4 Crest Factor	

Table A.25 Min/Max Log Results

CSP File No.	F27
Remote I/O BT	28
CIP Assy. Inst.	31
No. of Elements	11
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Comment
0	30801-02	Parameter # being returned	1 to 73	Refer to Reading Data from the Trend Log on page 7-12
1	30803-04	MIN value for parameter	-999.9×10^{21} to 999.9×10^{21}	
2	30805-06	MAX value for parameter	-999.9×10^{21} to 999.9×10^{21}	
3	30807-08	MIN timestamp; year	1998 to 2097	
4	30809-10	month/day	0101 to 1231	
5	30811-12	hour/minute	0000 to 2359	
6	30813-14	sec/hsec	0000 to 5999	
7	30815-16	MAX timestamp; year	1998 to 2097	
8	30817-18	month/day	0101 to 1231	
9	30819-20	hour/minute	0000 to 2359	
10	30821-22	sec/hsec	0000 to 5999	

Table A.26 Event Log Configuration/Read-Back Record Select

CSP File No.	N28
Remote I/O BT	9
CIP Assy. Inst.	32 (Write), 33 (Read)
No. of Elements	6
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All
Applies to:	Table 27: Event log results Table 49: Event log text

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	41001	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	41002	DeviceNet unique write identifier	-32768 to 32767	0	Refer to DeviceNet Unique Write Identifier on page 4-36
2	41003	Read-back mode	0 to 6	2	Refer to Configuring the Event Log Using Communications on page 7-4
3	41004	Enable/disable logging status input changes	0 to 1	0	
4	41005	# events in the event log	1 to 50 (M4,M5) 1 to 100 (M6, M8)	-	
5	41006	Enable/disable logging of time/date set	0 to 1	1	

Table A.27 Event Log Results

CSP File No.	N29
Remote I/O BT	21
CIP Assy. Inst.	34
No. of Elements	14, 17 or 18 (see table)
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	See table

Element No.	Modbus Address	M4 M5	M 6	M 8	Element name	Range	Comment
0	30901	•	•	•	Reserved	0	Returns 0.
1	30902	•	•	•	Internal identifier	0 to 32768	Refer to Reading Data from the Event Log Using Communications on page 7-5

Element No.	Modbus Address	M4 M5	M 6	M 8	Element name	Range	Comment
2	30903	•	•	•	Timestamp of event; Year	1998 to 2097	Refer to Expressing Data in Data Tables on page 4-18.
3	30904	•	•	•	Month/day	0101 to 1231	
4	30905	•	•	•	Hour/minute	0000 to 2359	
5	30906	•	•	•	Second/hsec	0000 to 5999	
6	30907	•	•	•	Event type	0 to 19	Refer to Table A.29 List of Event Types
7	30908	•	•	•	Event code	-	Refer to Reading Data from the Event Log Using Communications on page 7-5
8	30909	•	•	•	Setpoint type	0 to 52	
9	30910	•	•	•	Setpoint evaluation condition	0 to 5	
10	30911	•	•	•	Setpoint level integer	0 to 9999	
11	30912	•	•	•	exponent	-21 to 21	
12	30913	•	•	•	Setpoint action/release delay	0 to 3600 (M4, M5) 0 to 30000 (M6, M8)	
13	30914	•	•	•	Setpoint action	0 to 32 (M4, M5) 0 to 43 (M6, M8)	
14	30915		•	•	Sustain limit timer integer	0 to 9999	
15	30916		•	•	exponent	-4 to 21	
16	30917		•	•	Capture identifier	0 to 999	
17	30918			•	Event Text Available	0 to 1	Refer to Event Log User Comment Field (M8 only) on page 7-6

Table A.28 Status Error Codes

Bits	Hex	Description
bit 0	0001h	Master Module code flash status
bit 1	0002h	Master Module data flash status
bit 2	0004h	Master Module RAM Status
bit 3	0008h	Reserved for factory use
bit 4	0010h	Master Module NVRAM status
bit 5	0020h	Master Module data acquisition status
bit 6	0040h	Master Module real time clock status
bit 7	0080h	Reserved for factory use
bit 8	0100h	Reserved for factory use
bit 9	0200h	Display Module status
bit 10	0400h	Master Module watchdog timer status
bit 11	0800h	Master Module optional communications status
bit 12-15	1000h -8000h	Reserved for factory use

Table A.29 List of Event Types

Applies to:	Table A.27 Event Log Results
PM3000 Type	See table

Event Code.	M4 M5	M 6	M 8	Event type	Event Command Code	Comment
0	•	•	•	No event	0	The log starts with no events recorded
1	•	•	•	Setpoint triggered	Setpoint Number	A setpoint activated
2	•	•	•	Setpoint released		A previously active setpoint released
3	•	•	•	Relay force energized	Relay Number	1 = Form C relay, 2 = KYZ
4	•	•	•	Relay force de-energized		
5	•	•	•	Relay force released		
6	•	•	•	Status input set	Status Input Number	
7	•	•	•	Status input cleared		
8	•	•	•	KWh counter set or cleared	1	Records command action
8	•	•	•	KVARh counter set or cleared	2	
8	•	•	•	KVAh counter set or cleared	3	
8	•	•	•	Ah counter set or cleared	4	
8	•	•	•	All energy counters cleared	5	
8	•	•	•	Trend log cleared	6	
8	•	•	•	Min/max log cleared	7	
8	•	•	•	Factory defaults restored	8	
8	•	•	•	Status input #1 counter cleared	9	
8	•	•	•	Status input #2 counter cleared	10	
8	•	•	•	Reserved	11	
8	•	•	•	Single setpoint timer cleared	12	
8	•	•	•	All setpoint timers cleared	13	
9	•	•	•	Power-up	0	Control power was applied.
10	•	•	•	Power-down	0	Control power was lost or internal reset occurred.
11	•	•	•	Selftest failure	Status Error Code	Refer to Table A.28 Status Error Codes (bitfield)
12	•	•	•	Date/time set	0	The date and/or time was set or altered.
13	•	•	•	Change of non-setpoint config data	0	
14	•	•	•	Change of setpoint config data	0	
15	•	•	•	NVRAM Clr	0	NVRAM has been cleared due to an extended loss of control power or internal error.
16			•	Transient detected		
17			•	User Comment		User has manually entered a comment to record the impact of an event on your plant or process.
18	•	•	•	External Demand Sync Timeout		The demand delay expired before the next expected external demand sync
19	•	•	•	Comm Card Reset		An unexpected comm card condition has been detected and the master module has reset the comm card in an attempt to resume normal operation.

Table A.30 User-Configured Table Setup

CSP File No.	N30
Remote I/O BT	35
CIP Assy. Inst.	35 (Write), 36 (Read)
No. of Elements	26
User Configurable	No
Data Type	Integer
Data Access	Read /Write
PM3000 Type	All
Applies to:	Table A.31 User-Configured Table Results

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	41101	Password	0 to 9999	0	Required for configuration, returns -1.
1	41102	DF1 File No.	31	31	Refer to User-Configured Data Table on page 4-53
		Ethernet (CSP) File No. (Series A only)	31	31	
		RIO BT No.	62	62	
		DeviceNet Ass'y Inst.	1, 37	37	
		EtherNet/IP (CIP) Ass'y Inst.	1, 37	37	
		Modbus	1000	31	
2	41103	DeviceNet instance 1 data type	0 to 1	0	
3	41104	Selection for parameter #1	0 to 301	71 (L1-L2 V)	
4	41105	Selection for parameter #2		72 (L2-L3 V)	
5	41106	Selection for parameter #3		73 (L3-L1 V)	
6	41107	Selection for parameter #4		63 (I1)	
7	41108	Selection for parameter #5		64 (I2)	
8	41109	Selection for parameter #6		65 (I3)	
9	41110	Selection for parameter #7		90 (W)	
10	41111	Selection for parameter #8		98 (VA)	
11	41112	Selection for parameter #9		94 (VAR)	
12	41113	Selection for parameter #10		111 (PF)	
13	41114	Selection for parameter #11		100 (Dmd W)	
14	41115	Selection for parameter #12		122 (KWh)	
15	41116	Selection for parameter #13		130 (Status)	
16	41117	Selection for parameter #14		14 (Year)	

Element No.	Modbus Address	Element name	Range	Default Value	Comment
17	41118	Selection for parameter #15	0 to 301	21 (Mo/Dy)	Parameters 15 through 23 not supported by DeviceNet
18	41119	Selection for parameter #16		22 (Hr/min)	
19	41120	Selection for parameter #17		23 (Sec/hsc)	
20	41121	Selection for parameter #18		0	
21	41122	Selection for parameter #19			
22	41123	Selection for parameter #20			
23	41124	Selection for parameter #21			
24	41125	Selection for parameter #22			
25	41126	Selection for parameter #23			

Table A.31 User-Configured Table Results

CSP File No.	F31
Remote I/O BT	62
CIP Assy. Inst.	37
No. of Elements	14 (DeviceNet) or 23 (All other communications options)
User Configurable	Yes
Data Type	Floating Point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Comment
0	31001-02	User selected parameter #1	-	Parameters previously setup during a write to Table A.30
1	31003-04	User selected parameter #2	-	
2	31005-06	User selected parameter #3	-	
3	31007-08	User selected parameter #4	-	
4	31009-10	User selected parameter #5	-	
5	31011-12	User selected parameter #6	-	
6	31013-14	User selected parameter #7	-	
7	31015-16	User selected parameter #8	-	
8	31017-18	User selected parameter #9	-	
9	31019-20	User selected parameter #10	-	
10	31021-22	User selected parameter #11	-	
11	31023-24	User selected parameter #12	-	
12	31025-26	User selected parameter #13	-	
13	31027-28	User selected parameter #14	-	

Element No.	Modbus Address	Element name	Range	Comment
14	31029-30	User selected parameter #15	-	DeviceNet supports a maximum of 14 user-configured parameters.
15	31031-32	User selected parameter #16	-	
16	31033-34	User selected parameter #17	-	
17	31035-36	User selected parameter #18	-	
18	31037-38	User selected parameter #19	-	
19	31039-40	User selected parameter #20	-	
20	31041-42	User selected parameter #21	-	
21	31043-44	User selected parameter #22	-	
22	31045-46	User selected parameter #23	-	

Table A.32 Write Error Status

CSP File No.	N32
Remote I/O BT	4
CIP Assy. Inst.	38
No. of Elements	2
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	31101	File, instance or BT number	See Table A.1	- -	Identifies data table written to last, value depends on comms type. For Modbus, starting address of table written to last.
1	31102	Offending Element			-1 = Last write was successful 0 to 26 = first unacceptable element of unsuccessful write For Remote I/O Only: 0 = Last write was successful 1 t0 27 = First unacceptable word of unsuccessful write For Modbus Only: -1 = Last write was successful 40001 to 42001 - first unacceptable address of unsuccessful write.

Table A.33 Harmonic Analysis Configuration/Read-Back Select

CSP File No.	N33
Remote I/O BT	14
CIP Assy. Inst.	39 (Write), 40 (Read)
No. of Elements	9
User Configurable	No
Data Type	Integer
Data Access	Read /Write
PM3000 Type	See table
Applies to:	Table A.34 (All models) Table A.35,Table A.36, Table A.37, Table A.38 (M6 & M8) Table A.48, Table A.49 (M8 only)

Element No.	Modbus Address	M4 M5	M 6	M 8	Element name	Range	Default Value	Comment
0	41201	•	•	•	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	41202	•	•	•	Channel	1 to 9	1	Refer to Configuring Harmonic Analysis on page 8-10
2	41203	•	•	•	Read-back mode	0 to 1	0	
3	41204	•			Reserved	0	0	
			•	•	Individual harmonic data type	0 to 1	0	
4	41205	•			Reserved	0	0	
			•	•	Enable/disable Harmonics	0 to 1	1	
5	41206	•			Reserved	0	0	
			•	•	IEEE-519 Max I_{sc}Integer	0 to 9999	0	
6	41207	•			Reserved	0	0	
			•	•	IEEE-519 Max I_{sc}Exponent	-4 to 21	0	
7	41208	•			Reserved	0	0	
			•	•	IEEE 519 Max I_{dmnd}Integer	0 to 9999	0	
8	41209	•			Reserved	0	0	
			•	•	IEEE 519 Max I_{dmnd} Exponent	-4 to 21	0	

Table A.34 Harmonic Results; THD, Crest Factor, and More

CSP File No.	F34
Remote I/O BT	23
CIP Assy. Inst.	41
No. of Elements	9 (M4, M5); 10 (M6, M8)
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	See table

Element No.	Modbus Address	M4 M5	M 6	M 8	Element name	Range	Comment
0	31201-02	•	•	•	Channel number	1 to 9	Refer to Reading Harmonic Analysis Data on page 8-11
1	31203-04	•	•	•	% IEEE THD	0.0 to 1000.0	
2	31205-06	•	•	•	% IEC thd (DIN)	0.0 to 1000.0	
3	31207-08	•	•	•	Crest Factor	0.0 to 10.0	
4	31209-10	•	•	•	THD & Crest iteration	0 to 32767	
5	31211-12	•			Reserved	0	
			•	•	TIF	0.0 to $999.9x10^{22}$	
6	31213-14	•			Reserved	0	
			•	•	K-Factor	0.0 to $999.9x10^{22}$	
7	31215-16	•			Reserved	0	
			•	•	IEEE-519 TDD	0.0 to $999.9x10^{22}$	
8	31217-18	•			Reserved	0	
			•	•	IEEE-519 Pass/Fail	-1 to 1	
9	31219-20	•			Reserved	0	
			•	•	FFT iteration	0 to 32767	

Table A.35 Harmonic Results; Odd Harmonics 1 to 21

CSP File No.	F35
Remote I/O BT	39
CIP Assy. Inst.	42
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Channel # returned	1 to 7	Refer to Reading Harmonic Analysis Data on page 8-11
1	-	Type of harmonic data returned	0 to 1	
2	-	1st Harmonic (Fundamental)	0.0	
3	-	3rd Harmonic	0.0 to 999.9×10^{22}	
4	-	5th Harmonic	0.0 to 999.9×10^{22}	
5	-	7th Harmonic	0.0 to 999.9×10^{22}	
6	-	9th Harmonic	0.0 to 999.9×10^{22}	
7	-	11th Harmonic	0.0 to 999.9×10^{22}	
8	-	13th Harmonic	0.0 to 999.9×10^{22}	
9	-	15th Harmonic	0.0 to 999.9×10^{22}	
10	-	17th Harmonic	0.0 to 999.9×10^{22}	
11	-	19th Harmonic	0.0 to 999.9×10^{22}	
12	-	21st Harmonic	0.0 to 999.9×10^{22}	
13	-	FFT iteration	0 to 32767	

Table A.36 Harmonic Results; Odd Harmonics 23 to 41

CSP File No.	F36
Remote I/O BT	40
CIP Assy. Inst.	43
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Channel # returned	1 to 7	Refer to Reading Harmonic Analysis Data on page 8-11
1	-	Type of harmonic data returned	0 to 1	
2	-	Reserved	0	
3	-	23rd Harmonic	0.0 to $999.9x10^{22}$	
4	-	25th Harmonic	0.0 to $999.9x10^{22}$	
5	-	27th Harmonic	0.0 to $999.9x10^{22}$	
6	-	29th Harmonic	0.0 to $999.9x10^{22}$	
7	-	31st Harmonic	0.0 to $999.9x10^{22}$	
8	-	33rd Harmonic	0.0 to $999.9x10^{22}$	
9	-	35th Harmonic	0.0 to $999.9x10^{22}$	
10	-	37th Harmonic	0.0 to $999.9x10^{22}$	
11	-	39th Harmonic	0.0 to $999.9x10^{22}$	
12	-	41st Harmonic	0.0 to $999.9x10^{22}$	
13	-	FFT iteration	0 to 32767	

Table A.37 Harmonic Results; Even Harmonics 2 to 20

CSP File No.	F37
Remote I/O BT	41
CIP Assy. Inst.	44
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Channel # returned	1 to 7	Refer to Reading Harmonic Analysis Data on page 8-11
1	-	Type of harmonic data returned	0 to 1	
2	-	Reserved	0	
3	-	2nd Harmonic	0.0 to 999.9×10^{22}	
4	-	4th Harmonic	0.0 to 999.9×10^{22}	
5	-	6th Harmonic	0.0 to 999.9×10^{22}	
6	-	8th Harmonic	0.0 to 999.9×10^{22}	
7	-	10th Harmonic	0.0 to 999.9×10^{22}	
8	-	12th Harmonic	0.0 to 999.9×10^{22}	
9	-	14th Harmonic	0.0 to 999.9×10^{22}	
10	-	16th Harmonic	0.0 to 999.9×10^{22}	
11	-	18th Harmonic	0.0 to 999.9×10^{22}	
12	-	20th Harmonic	0.0 to 999.9×10^{22}	
13	-	FFT iteration	0 to 32767	

Table A.38 Harmonic Results; Even Harmonics 22 to 40

CSP File No.	F38
Remote I/O BT	42
CIP Assy. Inst.	45
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Channel # returned	1 to 7	Refer to Reading Harmonic Analysis Data on page 8-11
1	-	Type of harmonic data returned	0 to 1	
2	-	Reserved	0	
3	-	22^{nd} Harmonic	0.0 to $999.9x10^{22}$	
4	-	24^{th} Harmonic	0.0 to $999.9x10^{22}$	
5	-	26^{th} Harmonic	0.0 to $999.9x10^{22}$	
6	-	28^{th} Harmonic	0.0 to $999.9x10^{22}$	
7	-	30^{th} Harmonic	0.0 to $999.9x10^{22}$	
8	-	32^{nd} Harmonic	0.0 to $999.9x10^{22}$	
9	-	34^{th} Harmonic	0.0 to $999.9x10^{22}$	
10	-	36^{th} Harmonic	0.0 to $999.9x10^{22}$	
11	-	38^{th} Harmonic	0.0 to $999.9x10^{22}$	
12	-	40^{th} Harmonic	0.0 to $999.9x10^{22}$	
13	-	FFT iteration	0 to 32767	

Table A.39 Oscillograph Configuration/Read-Back Data Select

CSP File No.	N39
Remote I/O BT	15
CIP Assy. Inst.	46 (Write), 47 (Read)
No. of Elements	11
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M6, M8 only
Applies to:	Table A.40 Oscillograph Results

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	-	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	-	Capture No.	0 to 8 (M6) 0 to 2 (M8)	1	Refer to Configuring Oscillography on page 8-1
2	-	Channel No.	1 to 7	1	
3	-	Block No.	See page 8-3	1	
4	-	Read-back mode	0 to 2	0	
5	-	Clear/trigger command	0 to 10	0	
6	-	Capture type	-1 to 5	0	
7	-	% Pre-trigger	0 to 100	90	
8	-	Reserved	0	0	
9	-	Capture clear status	0 to 255	-	
10	-	Capture ready status	0 to 255	-	

Table A.40 Oscillograph Results

CSP File No.	N40
Remote I/O BT	61
CIP Assy. Inst.	48
No. of Elements	29 (DeviceNet only) 59 (all other communications types)
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	M6, M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Timestamp; Month/day	0000 to 1231	Trigger timestamp, see page 4-18.
1	-	Hour/minute	0000 to 2359	
2	-	Second/hsec	0000 to 5999	
3	-	Capture #	1 to 8 (M6) 1 to 2 (M8)	Refer to Reading Oscillograph Data on page 8-4
4	-	Channel number	1 to 7	
5	-	Block number	See page 80	
6	-	Capture type	0 to 5	
7	-	Trigger source and capture identifier	0 to 22999	
8	-	Trigger position	1 to 4600 1 to 9200	
9	-	Oscillograph Data Point 1	-8192 to 8191	
10	-	Oscillograph Data Point 2		
11	-	Oscillograph Data Point 3		
12	-	Oscillograph Data Point 4		
13	-	Oscillograph Data Point 5		
14	-	Oscillograph Data Point 6		
15	-	Oscillograph Data Point 7		
16	-	Oscillograph Data Point 8		
17	-	Oscillograph Data Point 9		
18	-	Oscillograph Data Point 10		
19	-	Oscillograph Data Point 11		
20	-	Oscillograph Data Point 12		
21	-	Oscillograph Data Point 13		
22	-	Oscillograph Data Point 14		
23	-	Oscillograph Data Point 15		
24	-	Oscillograph Data Point 16		
25	-	Oscillograph Data Point 17		
26	-	Oscillograph Data Point 18		
27	-	Oscillograph Data Point 19		
28	-	Oscillograph Data Point 20		

Element No.	Modbus Address	Element name	Range	Comment
29	-	Oscillograph Data Point 21		DeviceNet supports only 20 data points per read.
30	-	Oscillograph Data Point 22		
31	-	Oscillograph Data Point 23		
32	-	Oscillograph Data Point 24		
33	-	Oscillograph Data Point 25		
34	-	Oscillograph Data Point 26		
35	-	Oscillograph Data Point 27		
36	-	Oscillograph Data Point 28		
37	-	Oscillograph Data Point 29		
38	-	Oscillograph Data Point 30		
39	-	Oscillograph Data Point 31		
40	-	Oscillograph Data Point 32		
41	-	Oscillograph Data Point 33		
42	-	Oscillograph Data Point 34		
43	-	Oscillograph Data Point 35		
44	-	Oscillograph Data Point 36		
45	-	Oscillograph Data Point 37		
46	-	Oscillograph Data Point 38		
47	-	Oscillograph Data Point 39		
48	-	Oscillograph Data Point 40		
49	-	Oscillograph Data Point 41		
50	-	Oscillograph Data Point 42		
51	-	Oscillograph Data Point 43		
52	-	Oscillograph Data Point 44		
53	-	Oscillograph Data Point 45		
54	-	Oscillograph Data Point 46		
55	-	Oscillograph Data Point 47		
56	-	Oscillograph Data Point 48		
57	-	Oscillograph Data Point 49		
58	-	Oscillograph Data Point 50		

Table A.41 Load Factor Log Configuration/Read-Back Select

CSP File No.	N41
Remote I/O BT	16
CIP Assy. Inst.	49 (Write), 50 (Read)
No. of Elements	6
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M6, M8 only
Applies to:	Table A.42 Load Factor Log Results

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	-	Password	0 to 9999	0	Required for configuration or command, -1 for readback select, returns -1.
1	-	Record to read-back	0 to 12	0	Refer to Reading the Load Factor Log on page 8-17
2	-	Read-back mode	0 to 1	1	
3	-	Clear peak / reset average command	0 to 1	0	
4	-	Auto clear/reset day	0 to 31	31	
5	-	Reserved	0	0	

Table A.42 Load Factor Log Results

CSP File No.	F42
Remote I/O BT	43
CIP Assy. Inst.	51
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Peak Demand W	0.0 to $999.9x10^{21}$	Refer to Reading the Load Factor Log on page 8-17
1	-	Average Demand W	0.0 to $999.9x10^{21}$	
2	-	Load Factor W	0 to 100.0	
3	-	Peak Demand VAR	0.0 to $999.9x10^{21}$	
4	-	Average Demand VAR	0.0 to $999.9x10^{21}$	
5	-	Load Factor VAR	0 to 100.0	
6	-	Peak Demand VA	0.0 to $999.9x10^{21}$	
7	-	Average Demand VA	0.0 to $999.9x10^{21}$	
8	-	Load Factor VA	0 to 100.0	
9	-	Peak Demand I	0.0 to $999.9x10^{21}$	
10	-	Average Demand I	0.0 to $999.9x10^{21}$	
11	-	Load Factor I	0 to 100.0	
12	-	Elapsed time	0.0 to $999.9x10^{21}$	
13	-	Ending month/day/year	0 to 123199	

Table A.43 Transient Analysis Configuration/Read-Back Select

CSP File No.	F43
Remote I/O BT	44
CIP Assy. Inst.	52 (Write), 53 (Read)
No. of Elements	10
User Configurable	No
Data Type	Floating Point
Data Access	Read / Write
PM3000 Type	M8 only
Applies to:	Table 43: Transient analysis metering results

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	-	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	-	DeviceNet unique write identifier	-32768 to 32767	0	Refer to DeviceNet Unique Write Identifier on page 4-36.
2	-	Capture #	0 to 6	1	Refer to Transient Analysis Configuration on page 8-19.
3	-	Cycle #	1 to 12	1	
4	-	Read-back mode	0 to 1	0	
5	-	Detection mode	0 to 3	1	
6	-	Reserved	0	0	
7	-	Auto-threshold set command	0 to 1	0	
8	-	Auto-threshold set duration	1 to 3600	10	
9	-	Auto-threshold set margin	1.0 to 100.0	20.0	
10	-	Voltage trigger threshold	0.1 to 100.0	10.0	
11	-	Current trigger threshold	0.1 to 100.0	10.0	
12	-	Auto-threshold duration time left	0	0	

Table A.44 Transient Analysis Metering Results

CSP File No.	F44
Remote I/O BT	32
CIP Assy. Inst.	54
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Capture number	1 to 6	Refer to Reading Transient Analysis Metering Data on page 8-20.
1	-	Cycle number	1 to 12	
2	-	L1-L2 or L1-N Voltage	0.0 to 999.9×10^{21}	
3	-	L2-L3 or L2-N Voltage	0.0 to 999.9×10^{21}	
4	-	L3-L1 or L3-N Voltage	0.0 to 999.9×10^{21}	
5	-	L1 Current	0.0 to 999.9×10^{21}	
6	-	L2 Current	0.0 to 999.9×10^{21}	
7	-	L3 Current	0.0 to 999.9×10^{21}	
8	-	L4 Current	0.0 to 999.9×10^{21}	
9	-	Voltage Index at trigger	-999.0×10^{3} to 999.0×10^{3}	
10	-	Current Index at trigger	-999.0×10^{3} to 999.0×10^{3}	
11	-	Voltage Trigger Threshold	0.0 to 999.0×10^{3}	
12	-	Current Trigger Threshold	0.0 to 999.0×10^{3}	
13	-	Unique Transient Capture ID	0 to 30000	

Table A.45 Transient Capture Clear/Read-Back Data Select

CSP File No.	N45
Remote I/O BT	17
CIP Assy. Inst.	55 (Write), 56 (Read)
No. of Elements	13
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M8 only
Applies to:	Table 45: Transient capture results

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	-	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	-	Dnet unique write identifier	-32768 to 32767	0	Refer to DeviceNet Unique Write Identifier on page 4-36.
2	-	Capture number	0 to 6	1	Refer to Reading Transient Capture Data on page 8-21.
3	-	Channel number	1 to 7	1	
4	-	Block number	See page 90	1	
5	-	Read-back mode	0 to 2	0	
6	-	Clear command	0 to 3	0	
7	-	Reserved	0	0	
8	-	Reserved	0	0	
9	-	Reserved	0	0	
10	-	Capture clear status	0 to 63	-	
11	-	Capture ready status	0 to 63	-	
12	-	Reserved	0	0	

Table A.46 Transient Capture Results

CSP File No.	N46
Remote I/O BT	60
CIP Assy. Inst.	57
No. of Elements	29 (DeviceNet only); 59 (All other communications types)
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Timestamp; Month/day	0000 to 1231	Capture trigger timestamp, see page 4-18.
1	-	Hour/minute	0000 to 2359	
2	-	Second/hsec	0000 to 5999	
3	-	Capture #	1 to 6	Refer to Reading Transient Capture Data on page 8-21.
4	-	Channel number	1 to 7	
5	-	Block number	See page 8-22	
6	-	Reserved	0	
7	-	Unique Transient Capture ID	0 to 30000	
8	-	Reserved	0	
9	-	Data Point 1	-8192 to 8191	
10	-	Data Point 2		
11	-	Data Point 3		
12	-	Data Point 4		
13	-	Data Point 5		
14	-	Data Point 6		
15	-	Data Point 7		
16	-	Data Point 8		
17	-	Data Point 9		
18	-	Data Point 10		
19	-	Data Point 11		
20	-	Data Point 12		
21	-	Data Point 13		
22	-	Data Point 14		
23	-	Data Point 15		
24	-	Data Point 16		
25	-	Data Point 17		
26	-	Data Point 18		
27	-	Data Point 19		
28	-	Data Point 20		

Element No.	Modbus Address	Element name	Range	Comment
29	-	Data Point 21	-8192 to 8191	DeviceNet returns only 20 data points per read.
30	-	Data Point 22		
31	-	Data Point 23		
32	-	Data Point 24		
33	-	Data Point 25		
34	-	Data Point 26		
35	-	Data Point 27		
36	-	Data Point 28		
37	-	Data Point 29		
38	-	Data Point 30		
39	-	Data Point 31		
40	-	Data Point 32		
41	-	Data Point 33		
42	-	Data Point 34		
43	-	Data Point 35		
44	-	Data Point 36		
45	-	Data Point 37		
46	-	Data Point 38		
47	-	Data Point 39		
48	-	Data Point 40		
49	-	Data Point 41		
50	-	Data Point 42		
51	-	Data Point 43		
52	-	Data Point 44		
53	-	Data Point 45		
54	-	Data Point 46		
55	-	Data Point 47		
56	-	Data Point 48		
57	-	Data Point 49		
58	-	Data Point 50		

Table A.47 Advanced Metering Configuration

CSP File No.	N47
Remote I/O BT	19
CIP Assy. Inst.	58 (Write), 59 (Read)
No. of Elements	10
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M8 only

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	-	Password	0 to 9999	0	Required for configuration, returns -1.
1	-	Meter result set	0 to 2	0	Refer to Advanced Metering Options on page 3-27.
2	-	Reserved	0	0	Must be 0 on a write, returns 0
3	-				
4	-				
5	-				
6	-				
7	-				
8	-				
9	-				

Table A.48 Harmonic Results; Odd Harmonics 43 to 63

CSP File No.	F48
Remote I/O BT	45
CIP Assy. Inst.	60
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read Only
PM3000 Type	M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Channel # returned	1 to 7	Refer to Reading Individual Harmonic Values on page 8-12.
1	-	Type of harmonic data returned	0 to 1	
2	-	43rd Harmonic	0.0 to 999.9×10^{22}	
3	-	45th Harmonic		
4	-	47th Harmonic		
5	-	49th Harmonic		
6	-	51st Harmonic		
7	-	53rd Harmonic		
8	-	55th Harmonic		
9	-	57th Harmonic		
10	-	59th Harmonic		
11	-	61st Harmonic		
12	-	63rd Harmonic		
13	-	FFT iteration	0 to 32767	

Table A.49 Harmonic Results; Even Harmonics 42 to 62

CSP File No.	F49
Remote I/O BT	46
CIP Assy. Inst.	61
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read Only
PM3000 Type	M8 only

Element No.	Modbus Address	Element name	Range	Comment
0	-	Channel # returned	1 to 7	Refer to Reading Individual Harmonic Values on page 8-12.
1	-	Type of harmonic data returned	0 to 1	
2	-	42^{nd} Harmonic	0.0 to $999.9x10^{22}$	
3	-	44^{th} Harmonic		
4	-	46^{th} Harmonic		
5	-	48^{th} Harmonic		
6	-	50^{th} Harmonic		
7	-	52^{nd} Harmonic		
8	-	54^{th} Harmonic		
9	-	56^{th} Harmonic		
10	-	58^{th} Harmonic		
11	-	60^{th} Harmonic		
12	-	62^{nd} Harmonic		
13	-	FFT iteration	0 to 32767	

Table A.50 Event Log Text

CSP File No.	N50
Remote I/O BT	37
CIP Assy. Inst.	62 (Write), 63 (Read)
No. of Elements	22
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M8 only

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	-	Password	0 to 9999	0	Required for configuration, -1 for readback select, returns -1.
1	-	Write type	0 to 1	-	Refer to Event Log User Comment Field (M8 only) on page 7-6.
2	-	Dnet unique write identifier	-32768 to 32767	0	
3	-	Text block #	1 to 2	1	
4	-	Event record Internal identifier	-1 to 32767	-	
5	-	User-entered timestamp; Year	1998 to 2097		On a write, enter timestamp of user-entered new event, see page 4-18. On a read, return 0.
6	-	Month/day	0101 to 1231		
7	-	Hour/minute	0000 to 2359		
8	-	Second/hsec	0000 to 5999		
9	-	Reserved	0	0	
10	-	Text character pair #1	0 to 32382	-	
11	-	Text character pair #2			
12	-	Text character pair #3			
13	-	Text character pair #4			
14	-	Text character pair #5			
15	-	Text character pair #6			
16	-	Text character pair #7			
17	-	Text character pair #8			
18	-	Text character pair #9			
19	-	Text character pair #10			
20	-	Text character pair #11			
21	-	Text character pair #12			
22	-	Text character pair #13			

Table A.51 Catalog Number and WIN

CSP File No.	N51
Remote I/O BT	50
CIP Assy. Inst.	64
No. of Elements	29
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Comment
0	32301	Catalog # text char pair #1	-32768 to 32767	Catalog number without dashes. Each element contains a character pair. For each character pair, character 1 = element / 256 and character 2 = remainder. The 6th character of the catalog string reflects the *Current model* of the product.
1	32302	Catalog # text char pair #2		
2	32303	Catalog # text char pair #3		
3	32304	Catalog # text char pair #4		
4	32305	Catalog # text char pair #5		
5	32306	Catalog # text char pair #6		
6	32307	Catalog # text char pair #7		
7	32308	Reserved	0	Returns 0
8	32309			
9	32310	Hardware series	0 to 25	Indicates the series of the product; 0 = A, 1 = B, etc.
10	32311	WIN text character pair #1	-32768 to 32767	WIN (warranty identification number). This is the same 10-character alpha-numeric string printed on the master module label. Each element contains a character pair.
11	32312	WIN text character pair #2		
12	32313	WIN text character pair #3		
13	32314	WIN text character pair #4		
14	32315	WIN text character pair #5		
15	32316	Reserved	0	Returns 0
16	32317			
17	32318	Original model	0 to 9	The model as it was originally built. 4 = M4, 5 = M5, etc.
18	32319	Current model		Differs from *Original model* if field-upgraded
19	32320	Reserved	0	Returns 0
20	32321			
21	32322			
22	32323			
23	32324			
24	32325			
25	32326			
26	32327			
27	32328			
28	32329			

Table A.52 Network Demand Sync and Time Configuration

CSP File No.	N52
Remote I/O BT	-
CIP Assy. Inst.	65, 66
No. of Elements	20
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	Ethernet Series B

Element No.	Modbus Address	Parameter name	Range	Default Value	Description
0	41901	Password	0 to 9999	0	On a write, the correct password is required to change configuration data. On a read, -1 is returned.
1	41902	Input mode	0 to 3	3	Refer to Network Demand / Time Configuration on page 3-29.
2	41903	Broadcast port number	300 to 400	300	
3	41904	Time server IP address-byte 1	0 to 255	0	
4	41905	Time server IP address-byte 2			
5	41906	Time server IP address-byte 3			
6	41907	Time server IP address-byte 4			
7	41908	Time zone	-12 to 12	0	
8	41909	Time set update interval	0 to 32766	60 (Sec)	
9	41910	SNTP IP address 2, octet 1	0 to 255	0	SNTP IP address 2 is a back-up server address when the first address fails.
10	41911	SNTP IP address 2, octet 2		0	
11	41912	SNTP IP address 2, octet 3		0	
12	41913	SNTP IP address 2, octet 4		0	
13	41914	SNTP IP address 3, octet 1		0	SNTP IP address 3 is a back-up server address when the secnond address fails.
14	41915	SNTP IP address 3, octet 2		0	
15	41916	SNTP IP address 3, octet 3		0	
16	41917	SNTP IP address 3, octet 4		0	
17	41918	Reserved	0	0	Reserved for future use. On a write, only a 0 is accepted. On a read, always returns 0.
18	41919	Reserved	0	0	
19	41920	Reserved	0	0	

Table A.53 Controller Command

CSP File No.	N53
Remote I/O BT	-
CIP Assy. Inst.	67
No. of Elements	1
User Configurable	No
Data Type	Integer
Data Access	Write only
PM3000 Type	Series B Ethernet only

Element No.	Element name	Range	Default Value	Comment
0	Controller Command Bits 0	0 to 32767	0	Refer to Network Demand / Time Configuration on page 3-29

Table A.54 Daylight Saving Time Configuration

CSP File No.	N54
Remote I/O BT	47
CIP Assy. Inst.	68 (Write), 69 (Read)
No. of Elements	10
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Default	Comment
0	42101	Password	-1 to 9999	0	Required for configuration. Returns -1
1	42102	DST Enable	0 to 1	0	0 = Disabled, 1 = Enabled
2	42103	DST Start Month	1 to 12	4	1 = January, 2 = February, etc.
3	42104	DST Start Day	0 to 6	0	0 = Sunday, 1 = Monday, etc.
4	42105	DST Start Day Instance	1 to 5	1	1 = 1st, 2 = 2nd, ... 5 = Last
5	42106	DST Start Hour	0 to 23	2	0 = 12:00 midnight, 1 = 1:00 AM, etc.
6	42107	DST End Month	1 to 12	10	1 = January, 2 = February, etc.
7	42108	DST End Day	0 to 6	0	0 = Sunday, 1 = Monday, etc.
8	42109	DST End Day Instance	1 to 5	5	1 = 1st, 2 = 2nd, ... 5 = Last
9	43110	DST End Hour	0 to 23	2	0 = 12:00 midnight, 1 = 1:00 AM, etc.

Table A.55 Time of Use Register Configuration

CSP File No.	N55
Remote I/O BT	49
CIP Assy. Inst.	70 (Write), 71 (Read)
No. of Elements	10
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Default	Comment
0	42201	Password	-1 to 9999	0	Required for configuration, -1 for readback select, Returns -1
1	42202	Record to read back	0 to 12	0	Refer to Configuring the Time-of-Use Log on page 7-17
2	42203	Reserved	0	0	
3	42204	Write command	0 to 1	0	
4	42205	Log day	1 to 31	31	
5	42206	Off peak day	0 to 127	65	
6	42207	Mid peak a.m.	0 to 4095	1792	
7	42208	Mid peak p.m.		120	
8	42209	Peak a.m.		2048	
9	42210	Peak p.m.		7	

Table A.56 Time of Use Records – Real Energy and Demand

CSP File No.	F56
Remote I/O BT	51
CIP Assy. Inst.	72
No. of Elements	12
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Units	Comment
0	32301-02	Off-peak real energy	-999,999.0 to 999,999.0	MWh	Refer to Reading Time-of-Use Log Data on page 7-18
1	32303-04	Off-peak real energy	-999.999.999 to 999.999.999	kWh	
2	32305-06	Off-peak demand	0.0 to 999.9 x 10^{21}	Watts	
3	32307-08	Mid-peak real energy	-999,999.0 to 999,999.0	MWh	
4	32309-10	Mid-peak real energy	-999.999.999 to 999.999.999	kWh	
5	32311-12	Mid-peak demand	0.0 to 999.9 x 10^{21}	Watts	
6	32313-14	Peak real energy	-999,999.0 to 999,999.0	MWh	
7	32315-16	Peak real energy	-999.999.999 to 999.999.999	kWh	
8	32317-18	Peak demand	0.0 to 999.9 x 10^{21}	Watts	
9	32319-20	Start date	000101 to 991231	YYMMDD	Start month / day for data stored in this record, inclusive
10	32321-22	End date	000101 to 991231	YYMMDD	End month / day for data stored in this record, inclusive
11	33323-24	Record number	0 to 12		

Table A.57 Time of Use Records – Reactive Energy and Demand

CSP File No.	F57
Remote I/O BT	52
CIP Assy. Inst.	73
No. of Elements	12
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Units	Comment
0	32401-02	Off-peak reactive energy	-999,999.0 to 999,999.0	MVARh	Refer to Reading Time-of-Use Log Data on page 7-18
1	32403-04	Off-peak reactive energy	-999.999.999 to 999.999.999	kVARh	
2	32405-06	Off-peak demand VARs	0.0 to 999.9 x 10^{21}	VAR	
3	32407-08	Mid-peak reactive energy	-999,999.0 to 999,999.0	MVARh	
4	32409-10	Mid-peak reactive energy	-999.999.999 to 999.999.999	kVARh	
5	32411-12	Mid-peak demand VARs	0.0 to 999.9 x 10^{21}	VAR	
6	32413-14	Peak reactive energy	-999,999.0 to 999,999.0	MVARh	
7	32415-16	Peak reactive energy	-999.999.999 to 999.999.999	kVARh	
8	32417-18	Peak demand VARs	0.0 to 999.9 x 10^{21}	VAR	
9	32419-20	Start date	000101 to 991231	YYMMDD	Start month / day for data stored in this record, inclusive
10	32421-22	End date	000101 to 991231	YYMMDD	End month / day for data stored in this record, inclusive
11	33423-24	Record number	0 to 12		

Table A.58 Time of Use Records – Apparent Energy and Demand

CSP File No.	F58
Remote I/O BT	53
CIP Assy. Inst.	74
No. of Elements	12
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Element No.	Modbus Address	Element name	Range	Units	Comment
0	32501-02	Off-peak apparent energy	-999,999.0 to 999,999.0	MVAh	Refer to Reading Time-of-Use Log Data on page 7-18
1	32503-04	Off-peak apparent energy	-999.999.999 to 999.999.999	kVAh	
2	32505-06	Off-peak demand VA	0.0 to 999.9 x 10^{21}	VA	
3	32507-08	Mid-peak apparent energy	-999,999.0 to 999,999.0	MVAh	
4	32509-10	Mid-peak apparent energy	-999.999.999 to 999.999.999	kVAh	
5	32511-12	Mid-peak demand VA	0.0 to 999.9 x 10^{21}	VA	
6	32513-14	Peak apparent energy	-999,999.0 to 999,999.0	MVAh	
7	32515-16	Peak apparent energy	-999.999.999 to 999.999.999	kVAh	
8	32517-18	Peak demand VA	0.0 to 999.9 x 10^{21}	VA	
9	32519-20	Start date	000101 to 991231	YYMMDD	Start month / day for data stored in this record, inclusive
10	32521-22	End date	000101 to 991231	YYMMDD	End month / day for data stored in this record, inclusive
11	33523-24	Record number	0 to 12		

Table A.59 Parameters for Trend Log and Configurable Table

Applies to:	Table A.21 Trend Log Configuration/Read-Back Record Select Table A.22 Trend Log Results Table A.30 User-Configured Table Setup Table A.31 User-Configured Table Results
PM3000 Type	All

Param No.	Parameter name	Comment
0	None	No parameter
1	Relay output status	Refer to Table A.3 Discrete Data
2	Solid-state KYZ output status	
3	Alarm output word	
4	Status inputs state	
5	Status input #1 counter	
6	Status input #2 counter	
7	Voltage Mode (Wiring Configuration)	Refer to Table A.4 Basic Device Configuration
8	PT Primary	
9	PT Secondary	
10	I1/I2/I3 CT Primary	
11	I1/I2/I3 CT Secondary	
12	I4 CT Primary	
13	I4 CT Secondary	

Param No.	Parameter name	Comment
14	Date: Year	Refer to Table A.5 Date and Time
15	Date: Month	
16	Date: Day	
17	Time: Hour	
18	Time: Minute	
19	Time: Seconds	
20	Time: Hundredths of seconds	
21	Date: Month/day	Refer to Table A.5 Date and Time (compacted to take less space)
22	Time: Hour/minute	
23	Time Second/hsec	
24	Demand Period Length	Refer to Table A.6 Advanced Device Configuration
25	Number of Demand Periods	
26	Predicted Demand Type	
27	KYZ Pulse Output Parameter	
28	KYZ Pulse Output Scale	
29	KYZ Pulse Output Width	
30	Relay Pulse Output Parameter	
31	Relay Pulse Output Scale	
32	Relay Pulse Output Width	
33	RMS Resolution	
34	RMS result averaging	
35	Frequency averaging	
36	Default relay state in event of communications loss	
37	Default KYZ state in event of communications loss	
38	DM text scroll rate	
39	Protocol	Refer to Table A.7 Native Communication Configuration
40	Delay	
41	Baud rate	
42	Device address	
43	Data format	

Param No.	Parameter name	Comment
14	Date: Year	Refer to Table A.5 Date and Time
15	Date: Month	
16	Date: Day	
17	Time: Hour	
18	Time: Minute	
19	Time: Seconds	
20	Time: Hundredths of seconds	
21	Date: Month/day	Refer to Table A.5 Date and Time (compacted to take less space)
22	Time: Hour/minute	
23	Time Second/hsec	
24	Demand Period Length	Refer to Table A.6 Advanced Device Configuration
25	Number of Demand Periods	
26	Predicted Demand Type	
27	KYZ Pulse Output Parameter	
28	KYZ Pulse Output Scale	
29	KYZ Pulse Output Width	
30	Relay Pulse Output Parameter	
31	Relay Pulse Output Scale	
32	Relay Pulse Output Width	
33	RMS Resolution	
34	RMS result averaging	
35	Frequency averaging	
36	Default relay state in event of communications loss	
37	Default KYZ state in event of communications loss	
38	DM text scroll rate	
39	Protocol	Refer to Table A.7 Native Communication Configuration
40	Delay	
41	Baud rate	
42	Device address	
43	Data format	

Param No.	Parameter name	Comment
44	Comm parameter #1	Refer to Table A.8 Optional Communication Configuration
45	Comm parameter #2	
46	Comm parameter #3	
47	Comm parameter #4	
48	Comm parameter #5	
49	Comm parameter #6	
50	Comm parameter #7	
51	Comm parameter #8	
52	Comm parameter #9	
53	Comm parameter #10	
54	Comm parameter #11	
55	Comm parameter #12	
56	Comm parameter #13	
57	Comm parameter #14	
58	Comm parameter #15	
59	Comm parameter #16	
60	Comm parameter #17	
61	Comm parameter #18	
62	Comm parameter #19	
63	L1 Current	Refer to Table A.9 Metering Voltage, Current and Frequency Result
64	L2 Current	
65	L3 Current	
66	Avg Current	
67	L1-N Voltage	
68	L2-N Voltage	
69	L3-N Voltage	
70	Avg L-N Voltage	
71	L1-L2 Voltage	
72	L2-L3 Voltage	
73	L3-L1 Voltage	
74	Avg L-L Voltage	
75	Frequency, last cycle	
76	Metering iteration	
77	L4 Current	Refer to Table A.10 Metering Sequence Voltage and Current Results
78	Positive Sequence Current	
79	Negative Sequence Current	
80	% Current unbalance	
81	Positive Sequence Voltage	
82	Negative Sequence Voltage	
83	% Voltage unbalance	
84	Phase rotation	
85	Average frequency	
86	Frequency source	

Param No.	Parameter name	Comment
87	L1 Real Power	Refer to Table A.11 Metering Power Results
88	L2 Real Power	
89	L3 Real Power	
90	Total Real Power	
91	L1 Reactive Power	
92	L2 Reactive Power	
93	L3 Reactive Power	
94	Total Reactive Power	
95	L1 Apparent Power	
96	L2 Apparent Power	
97	L3 Apparent Power	
98	Total Apparent Power	
99	Demand Current	Refer to Table A.12 Metering Demand Results
100	Demand Power	
101	Demand Reactive Power	
102	Demand Apparent Power	
103	Projected Demand I	
104	Projected Demand W	
105	Projected Demand VAR	
106	Projected Demand VA	
107	Elapsed demand period time	
108	L1 True Power Factor	Refer to Table A.13 Metering Power Factor Results
109	L2 True Power Factor	
110	L3 True Power Factor	
111	3-phase True PF	
112	L1 Displacement Power Factor	
113	L2 Displacement Power Factor	
114	L3 Displacement Power Factor	
115	3-phase Displacement PF	
116	L1 Distortion Power Factor	
117	L2 Distortion Power Factor	
118	L3 Distortion Power Factor	
119	3-phase Distortion PF	
120	KWh forward	Refer to Table A.14 Metering Real and Apparent Energy Results
121	KWh reverse	
122	Kwh net	
123	KVAh	
124	KVARh forward	Refer to Table A.15 Metering Reactive Energy and Amp-Hour Results
125	KVARh reverse	
126	KVARh net	
127	KAh	

Param No.	Parameter name	Comment
128	Bulletin number	Refer to Table A.16 Selftest/Diagnostic Results
129	Series	
130	Overall status	
131	ASIC status	
132	Data FLASH status	
133	Real-time clock status	
134	RTC NVRAM status	
135	Option comm status	
136	Display module status	
137	Watchdog status	
138	VCO lock status	
139	Reserved	
140	Application FRN	
141	Boot code FRN	
142	ASIC 'FRN'	
143	Option comm FRN	
144	Display module FRN	
145	Reserved	
146	Digital board revision	
147	Analog board revision	
148	Option comm board revision	
149	Reserved	
150	MM Device ID	
151	MM RAM type	
152	Display module type	
153	Option comm type	
154	Reserved	

Param No.	Parameter name	Comment
155	Setpoint #1 type	Refer to Table A.18 Setpoint Setup/Read-Back Select and Status
156	Setpoint #2 type	
157	Setpoint #3 type	
158	Setpoint #4 type	
159	Setpoint #5 type	
160	Setpoint #6 type	
161	Setpoint #7 type	
162	Setpoint #8 type	
163	Setpoint #9 type	
164	Setpoint #10 type	
165	Setpoint #1 evaluation condition	
166	Setpoint #2 evaluation condition	
167	Setpoint #3 evaluation condition	
168	Setpoint #4 evaluation condition	
169	Setpoint #5 evaluation condition	
170	Setpoint #6 evaluation condition	
171	Setpoint #7 evaluation condition	
172	Setpoint #8 evaluation condition	
173	Setpoint #9 evaluation condition	
174	Setpoint #10 evaluation condition	
175	Setpoint #1 high limit	
176	Setpoint #2 high limit	
177	Setpoint #3 high limit	
178	Setpoint #4 high limit	
179	Setpoint #5 high limit	
180	Setpoint #6 high limit	
181	Setpoint #7 high limit	
182	Setpoint #8 high limit	
183	Setpoint #9 high limit	
184	Setpoint #10 high limit	
185	Setpoint #1 low limit	
186	Setpoint #2 low limit	
187	Setpoint #3 low limit	
188	Setpoint #4 low limit	
189	Setpoint #5 low limit	
190	Setpoint #6 low limit	
191	Setpoint #7 low limit	
192	Setpoint #8 low limit	
193	Setpoint #9 low limit	
194	Setpoint #10 low limit	
195	Setpoint #1 action delay	
196	Setpoint #2 action delay	
197	Setpoint #3 action delay	

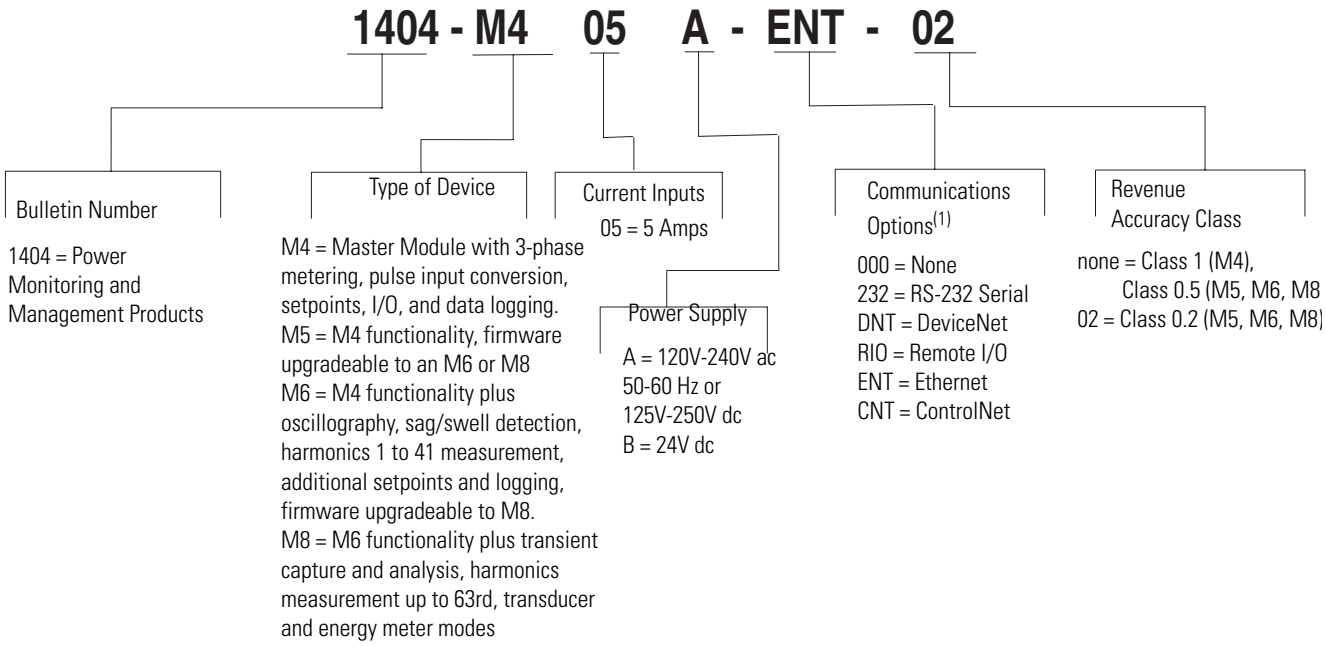
Param No.	Parameter name	Comment
198	Setpoint #4 action delay	Refer to Table A.18 Setpoint Setup/Read-Back Select and Status
199	Setpoint #5 action delay	
200	Setpoint #6 action delay	
201	Setpoint #7 action delay	
202	Setpoint #8 action delay	
203	Setpoint #9 action delay	
204	Setpoint #10 action delay	
205	Setpoint #1 release delay	
206	Setpoint #2 release delay	
207	Setpoint #3 release delay	
208	Setpoint #4 release delay	
209	Setpoint #5 release delay	
210	Setpoint #6 release delay	
211	Setpoint #7 release delay	
212	Setpoint #8 release delay	
213	Setpoint #9 release delay	
214	Setpoint #10 release delay	
215	Setpoint #1 action type	
216	Setpoint #2 action type	
217	Setpoint #3 action type	
218	Setpoint #4 action type	
219	Setpoint #5 action type	
220	Setpoint #6 action type	
221	Setpoint #7 action type	
222	Setpoint #8 action type	
223	Setpoint #9 action type	
224	Setpoint #10 action type	
225	Setpoint #1 status	
226	Setpoint #2 status	
227	Setpoint #3 status	
228	Setpoint #4 status	
229	Setpoint #5 status	
230	Setpoint #6 status	
231	Setpoint #7 status	
232	Setpoint #8 status	
233	Setpoint #9 status	
234	Setpoint #10 status	
235	Setpoint #1 accumulated active time	
236	Setpoint #2 accumulated active time	
237	Setpoint #3 accumulated active time	
238	Setpoint #4 accumulated active time	
239	Setpoint #5 accumulated active time	
240	Setpoint #6 accumulated active time	

Param No.	Parameter name	Comment
241	Setpoint #7 accumulated active time	Refer to Table A.18 Setpoint Setup/Read-Back Select and Status
242	Setpoint #8 accumulated active time	
243	Setpoint #9 accumulated active time	
244	Setpoint #10 accumulated active time	
245	Logging interval	Refer to Table A.21 Trend Log Configuration/Read-Back Record Select
246	Logging mode	
247	Total records logged	
248	Trend log param #1	
249	Trend log param #2	
250	Trend log param #3	
251	Trend log param #4	
252	Trend log param #5	
253	Trend log param #6	
254	Trend log param #7	
255	Trend log param #8	
256	Trend log param #9	
257	Trend log param #10	
258	Trend log param #11	
259	Trend log param #12	
260	Trend log param #13	
261	Trend log param #14	
262	Trend log param #15	
263	Trend log param #16	
264	Enable/disable Min/max log	Refer to Table A.23 Min/Max Log Configuration/Read-Back Select
265	Timestamp of last min/max clear; year	
266	Timestamp of last min/max clear; Month/day	
267	Timestamp of last min/max clear; Hour/min	
268	Timestamp of last min/max clear; Second/hsec	
269	Enable/disable save status input changes to Event log	Refer to Table A.26 Event Log Configuration/Read-Back Record Select
270	Number of events in the event log	
271	Write error status File/BT/Inst.No.	Refer to Table A.32 Write Error Status
272	Write error status Parameter number	

Param No.	Parameter name	Comment
273	V1 % IEEE THD	Refer to Table A.34 Harmonic Results; THD, Crest Factor, and More
274	I1 % IEEE THD	
275	V2 % IEEE THD	
276	I2 % IEEE THD	
277	V3 % IEEE THD	
278	I3 % IEEE THD	
279	I4 % IEEE THD	
280	V1 % IEC THD (DIN)	
281	I1 % IEC THD (DIN)	
282	V2 % IEC THD (DIN)	
283	I2 % IEC THD (DIN)	
284	V3 % IEC THD (DIN)	
285	I3 % IEC THD (DIN)	
286	I4 % IEC THD (DIN)	
287	V1 Crest Factor	
288	I1 Crest Factor	
289	V2 Crest Factor	
290	I2 Crest Factor	
291	V3 Crest Factor	
292	I3 Crest Factor	
293	I4 Crest Factor	
294	THD & Crest iteration	
295	DeviceNet instance 1 data type	Refer to Table A.30 User-Configured Table Setup
296	Avg IEEE THD V	Refer to Table A.34 Harmonic Results; THD, Crest Factor, and More
297	Avg IEEE THD I	
298	Avg IEC THD V	
299	Avg IEC THD I	
300	Avg Crest Factor V	
301	Avg Crest Factor I	

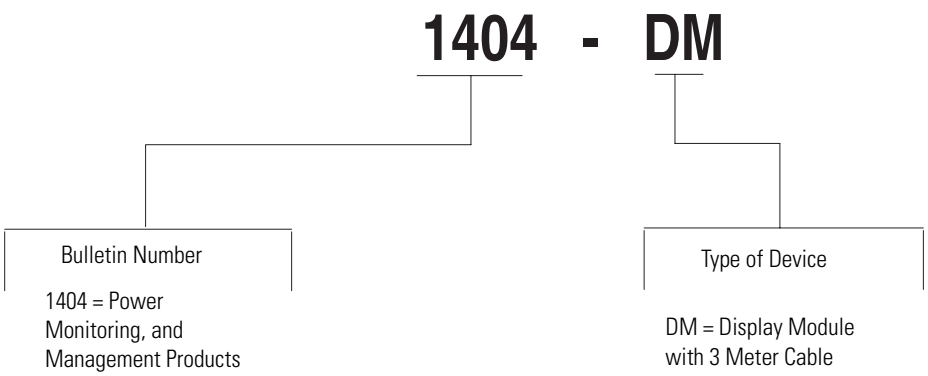
Catalog Number Explanation

Master Module


1404 - M4 05 A - ENT - 02
Bulletin Number
1404 = Power Monitoring and Management Products
Type of Device
M4 = Master Module with 3-phase metering, pulse input conversion, setpoints, I/O, and data logging.
M5 = M4 functionality, firmware upgradeable to an M6 or M8
M6 = M4 functionality plus oscillography, sag/swell detection, harmonics 1 to 41 measurement, additional setpoints and logging, firmware upgradeable to M8.
M8 = M6 functionality plus transient capture and analysis, harmonics measurement up to 63rd, transducer and energy meter modes
Current Inputs
05 = 5 Amps
Power Supply
A = 120V-240V ac 50-60 Hz or 125V-250V dc
B = 24V dc
Communications Options(1)
000 = None
232 = RS-232 Serial
DNT = DeviceNet
RIO = Remote I/O
ENT = Ethernet
CNT = ControlNet
Revenue Accuracy Class
none = Class 1 (M4), Class 0.5 (M5, M6, M8
02 = Class 0.2 (M5, M6, M8)

(1) In addition to Native RS-485 port.

Display Module


1404 - DM
Bulletin Number
1404 = Power Monitoring, and Management Products
Type of Device
DM = Display Module with 3 Meter Cable

Sample Applications

Introduction

This Appendix contains sample applications including ladder diagrams to help you get started in setting up communications between your application and a Powermonitor 3000.

The application samples depict basic methods for reading and writing data between a Powermonitor 3000 and your programmable controller or other application. Expand on these basic steps to customize your application to meet your business needs. The sample applications included are:

1. Read and write the Powermonitor 3000 system clock using a variety of controllers, applications and communications
2. Read multiple Powermonitor 3000 data tables into a SLC 500 controller using DeviceNet communications
3. Set up the user-configured data table using a ControlLogix controller and EtherNet/IP communications
4. Communications reading and writing Powermonitor tables using an SLC and 1747-SCNR ControlNet scanner.

ATTENTION

Proper operation of the application is the responsibility of the user. Rockwell Automation makes no warranty, express or implied, for these sample applications. The sample applications are subject to change at any time without notice.

System Clock Sample Applications

The Powermonitor 3000 system clock (date and time) is an ideal sample application for several reasons:

- It is important to set the system clock so that data log records, oscillograms, etc. are recorded with accurate time stamps
- It is easy to see if your application has successfully written and read the system clock
- The methods used for reading and writing the system clock are applicable to reading and writing every other Powermonitor 3000 data table.
- Read or write selectable data tables using an SLC 5/05 controller and ControlNet Scanner and unscheduled messaging

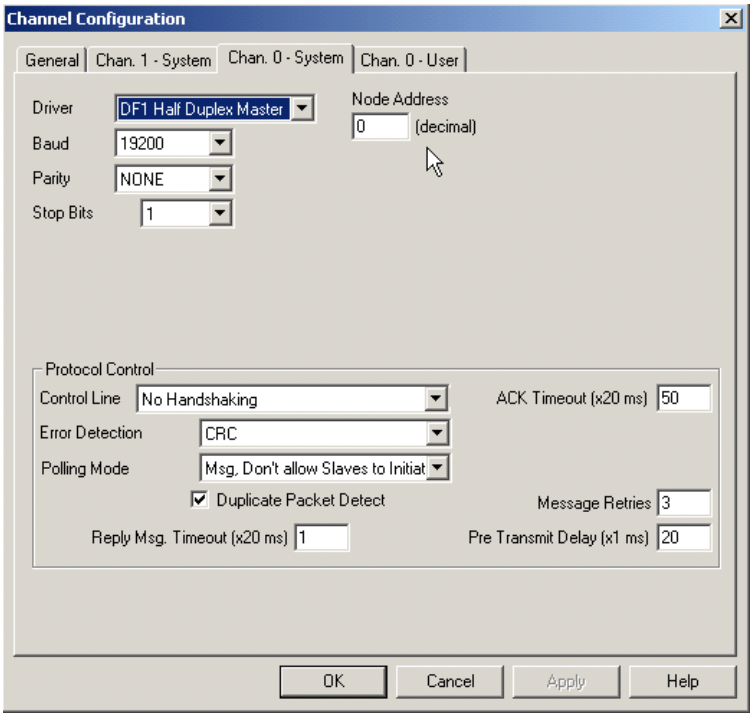
See Table A.5 on page A-8 for details of the Date and Time data table. We will look at four methods of reading and writing the system clock.

SLC 500 Controller and Native RS-485 Communications

This example reads and writes the date and time table using the SLC 500 controller Channel 0 serial port and the native RS-485 communications port on the Powermonitor 3000. You must supply an RS-232 to RS-485 converter such as a 1761-NET-AIC or B&B Electronics 485SD9TB between the SLC 500 controller and the Powermonitor 3000.

Serial Port Setup

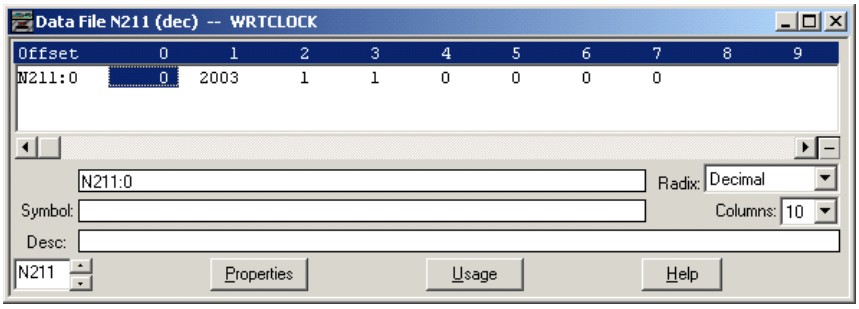
The SLC 500 serial port setup using a 1761-NET-AIC adapter is shown in Figure . The specific settings will depend on your selection of RS-485 to RS-232 adapter.



Data Tables

In the SLC 500 data tables, table N111 is the destination table for the Read message and N211 is the source for the Write message.

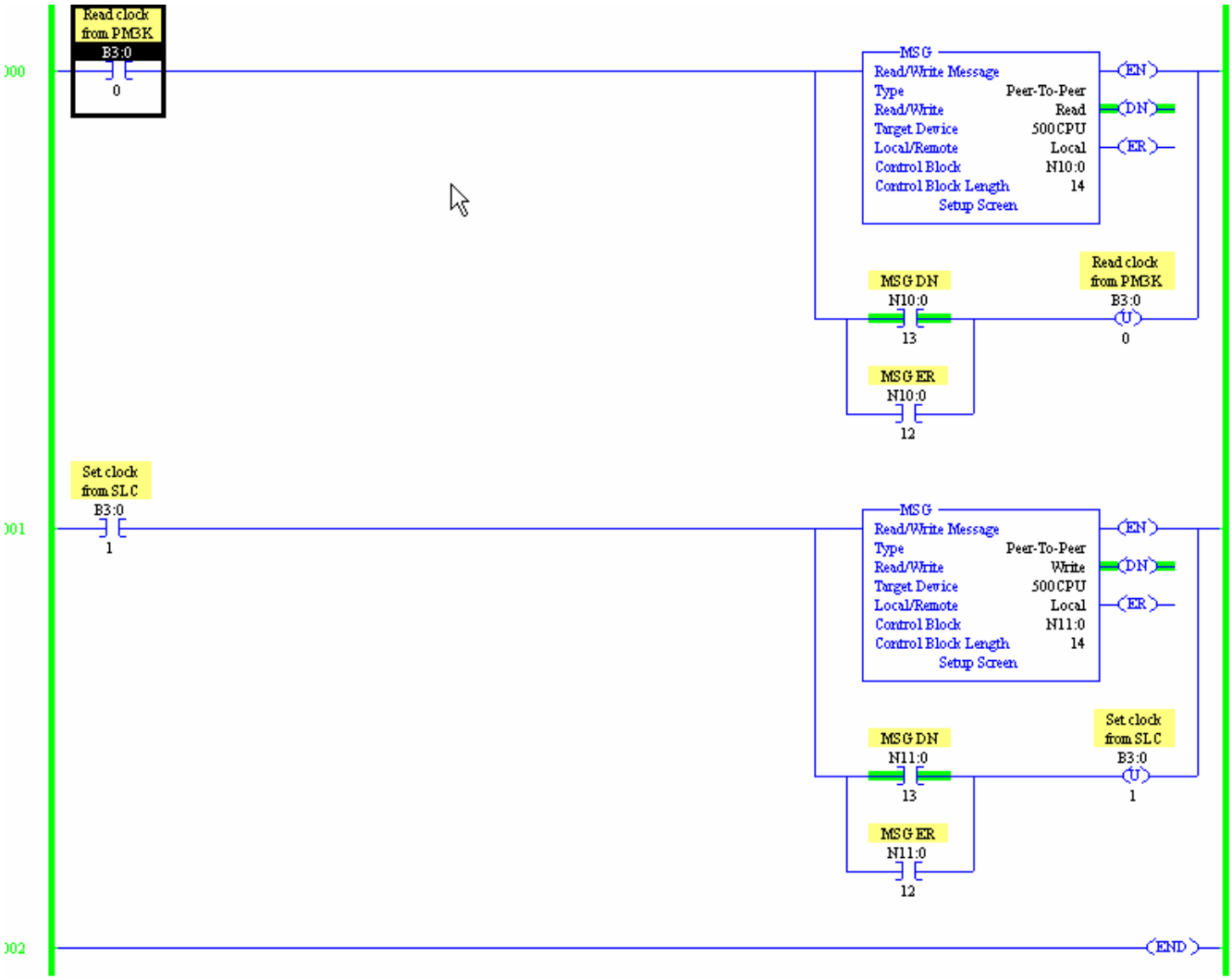
Table N211 contains the following values for setting the date and time in a Powermonitor 3000 with a password of 0 to January 1, 2003 at 12:00 midnight:



The Read Clock from PM3K and Set Clock from SLC bits are used to initiate the messages, and are reset when the message instruction either completes successfully or an error occurs. In your application

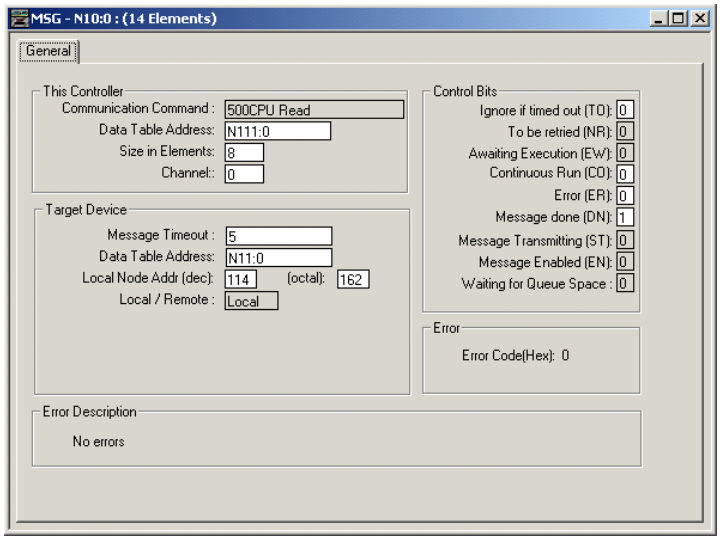
code, if the message rungs are controlled programmatically, ensure that only one message is enabled at a time.

Ladder Diagram

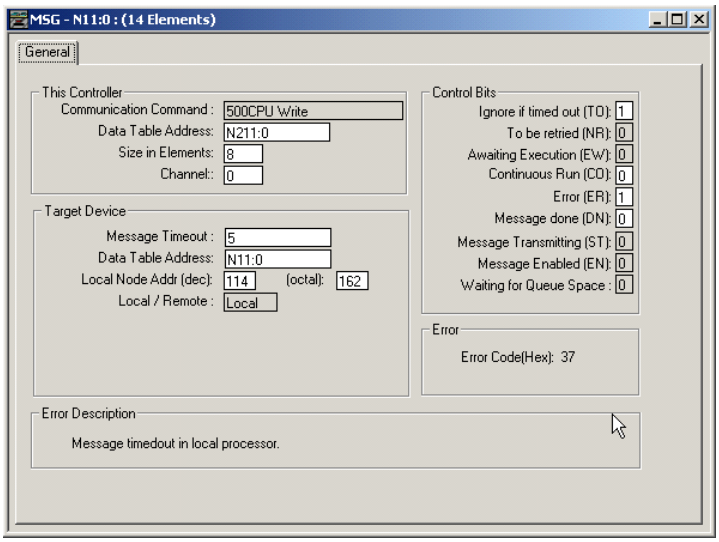


Message Setup Dialogs

This is the Read message dialog:



The Write message setup is similar:



MicroLogix 1500 using Modbus

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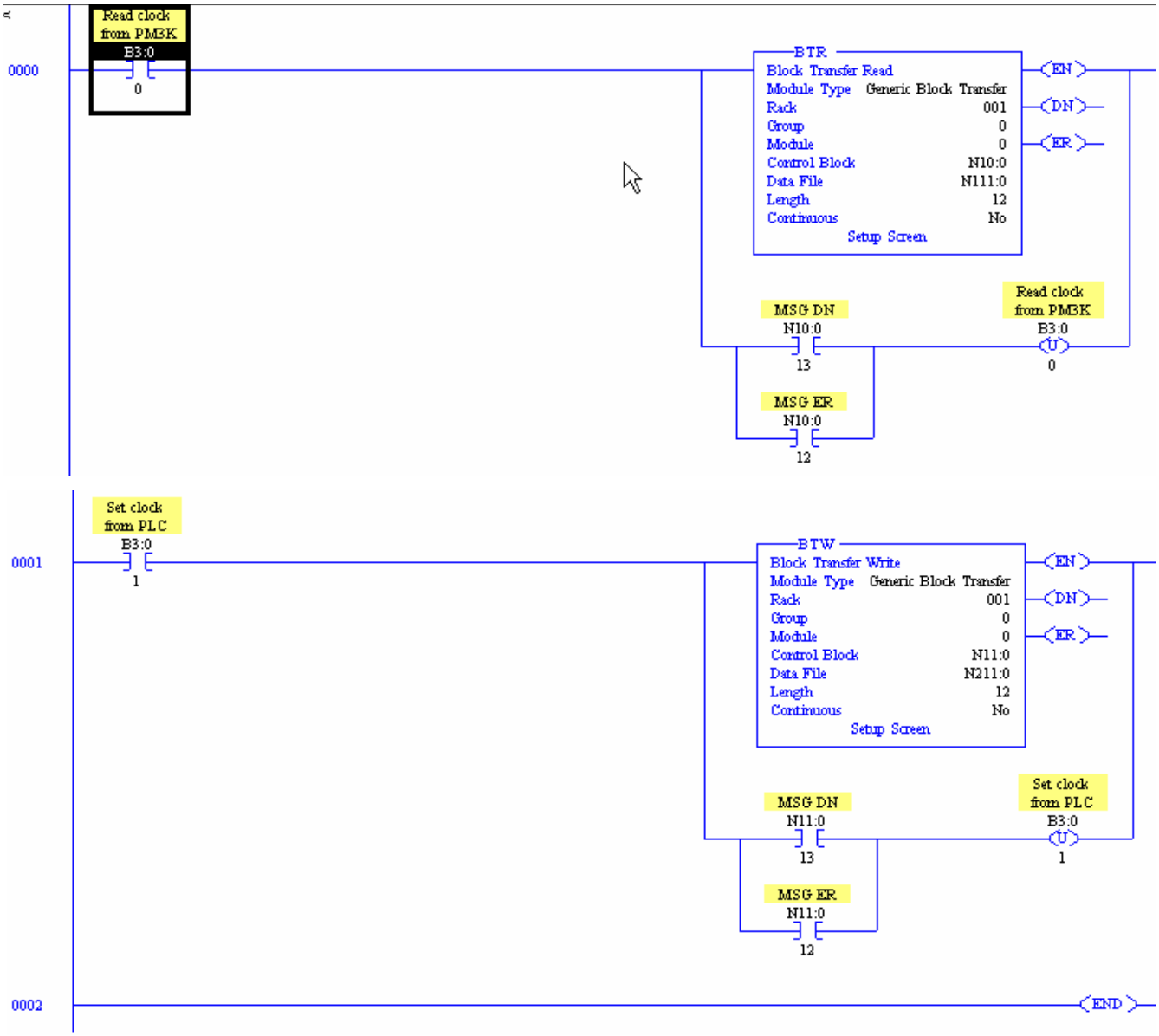
PLC-5 Controller Using Remote I/O

The second example also reads and writes the Powermonitor 3000 date and time but using a PLC-5 controller and Remote I/O. In this example, a Powermonitor 3000 has a logical address of Rack 1, Group 0. The PLC-5 data table files used are the same as in the previous example. The main difference is that this example uses block transfer instructions rather than message instructions, and the block transfer length determines which data table is selected.

The source and destination data tables in the PLC-5 must contain at least as many words as the block transfer length.

The Read Clock from PM3K and Set Clock from PLC bits are used to initiate the messages, and are reset when the message instruction either completes successfully or an error occurs. In your application code, if the message rungs are controlled programmatically, ensure that only one message is enabled at a time, and add sufficient time delays between block transfers to avoid overloading the channel.

Ladder Diagram



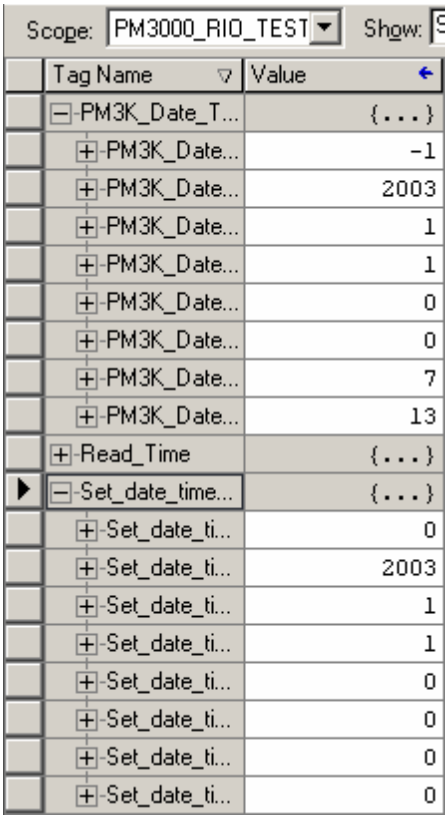
EtherNet/IP and ControlLogix

The third example reads and writes the Powermonitor 3000 date and time data table using a ControlLogix controller and EtherNet/IP communications. Note that the Powermonitor 3000 Ethernet port

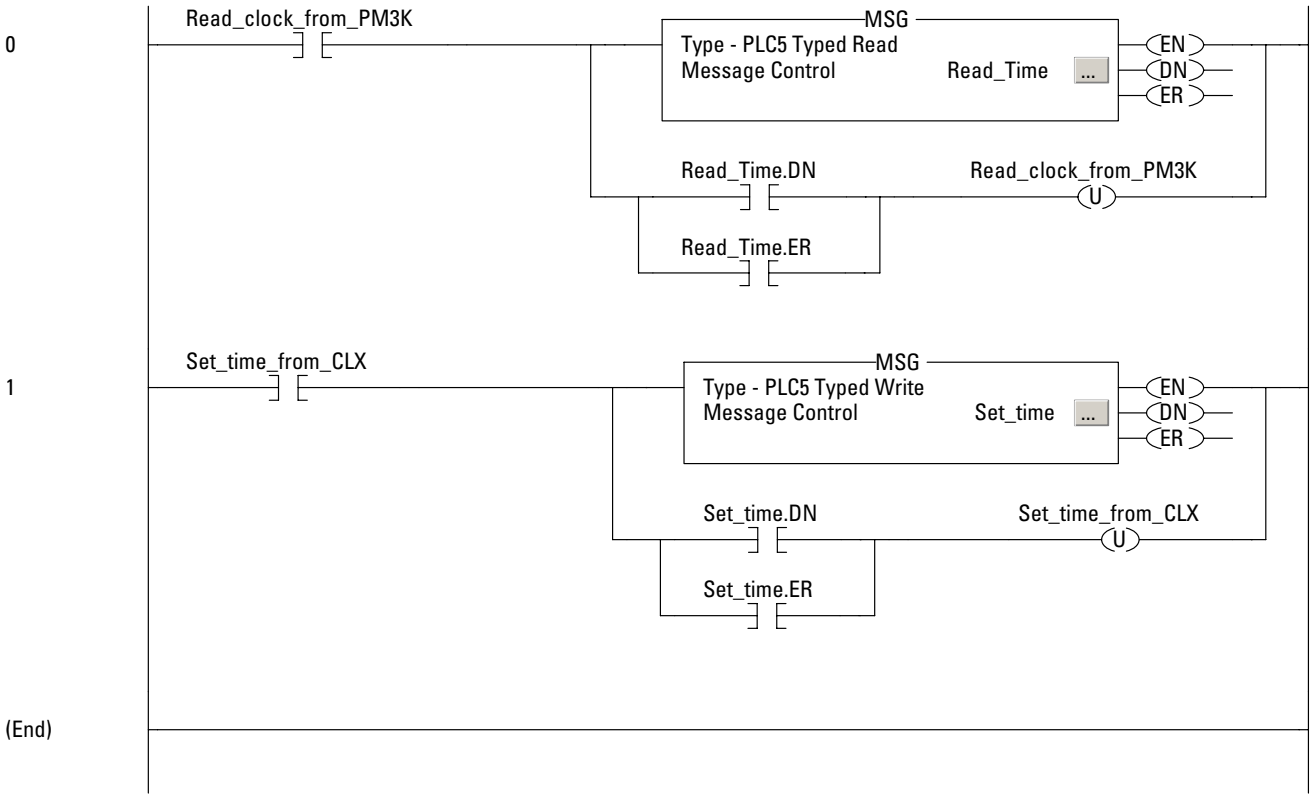
protocol must be CIP or CSP/CIP dual stack to enable communications with the ControlLogix controller.

Tags

The example uses two ControlLogix tags, PM3K_Date_Time and Set_date_time. Both are arrays of 8 INT elements. The program also uses two standard MESSAGE tags, Read_time and Set_time. The following figure shows the Set_date_time to set the Powermonitor 3000 clock to January 1, 2003 at midnight. The tag PM3K_Date_Time shows the results of a read 7.13 seconds after the write.



Ladder Diagram



Message Setup Dialogs

The example uses PLC-5 Typed read and write message types. The setup dialogs are similar to those found on page 4-41 and page 4-42.

ControlNet and ControlLogix

The fourth example reads and writes the Powermonitor 3000 date and time using a ControlLogix controller and ControlNet communications.

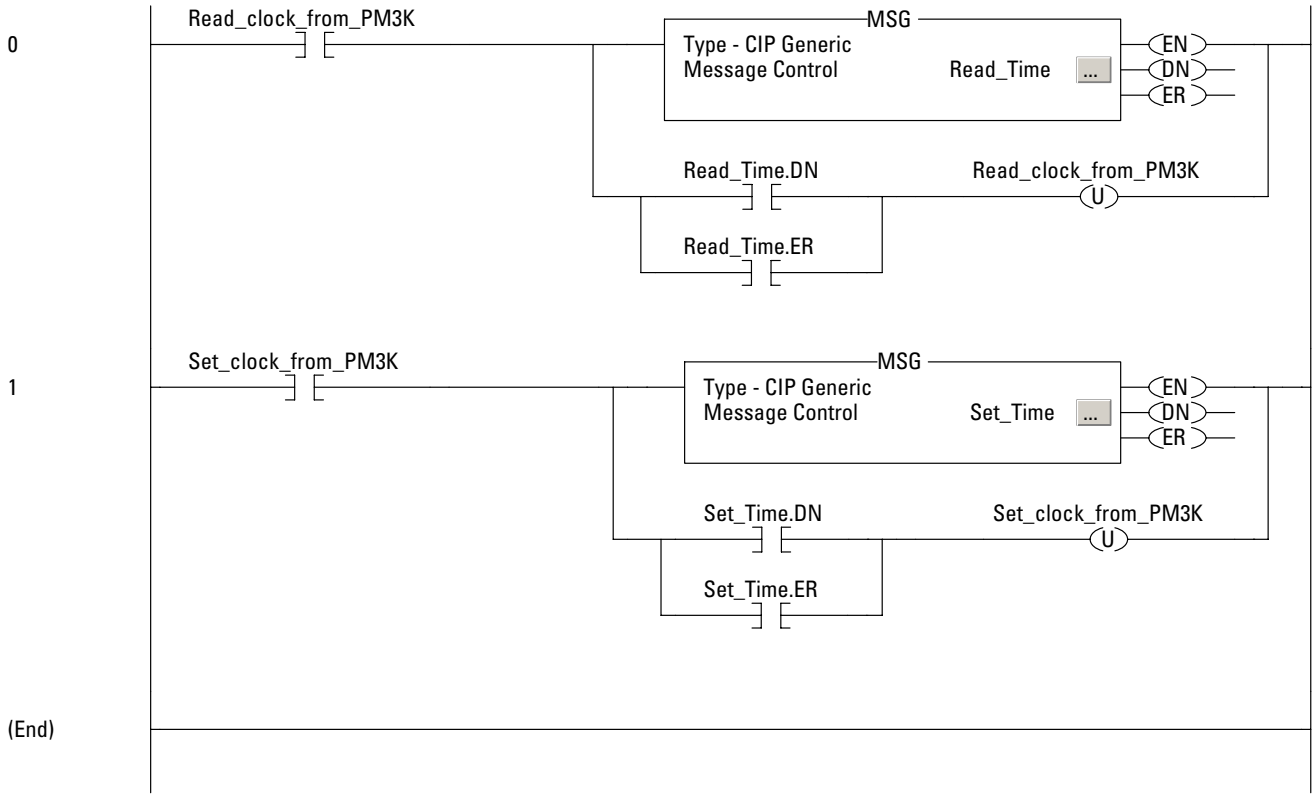
Tags

The example uses two ControlLogix tags as shown below. The tags are INT(8) arrays.

Date_time_from_PM3K	{...}
Date_time_from_PM3K[0]	-1
Date_time_from_PM3K[1]	2003
Date_time_from_PM3K[2]	4
Date_time_from_PM3K[3]	14
Date_time_from_PM3K[4]	12
Date_time_from_PM3K[5]	29
Date_time_from_PM3K[6]	3
Date_time_from_PM3K[7]	47

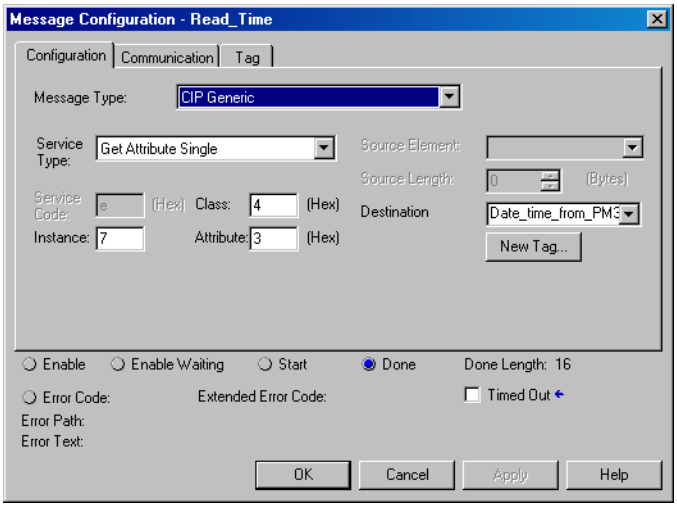
Set_PM3K_Date_Time	{...}
Set_PM3K_Date_Time[0]	0
Set_PM3K_Date_Time[1]	2003
Set_PM3K_Date_Time[2]	4
Set_PM3K_Date_Time[3]	14
Set_PM3K_Date_Time[4]	12
Set_PM3K_Date_Time[5]	29
Set_PM3K_Date_Time[6]	0
Set_PM3K_Date_Time[7]	0

Ladder diagram

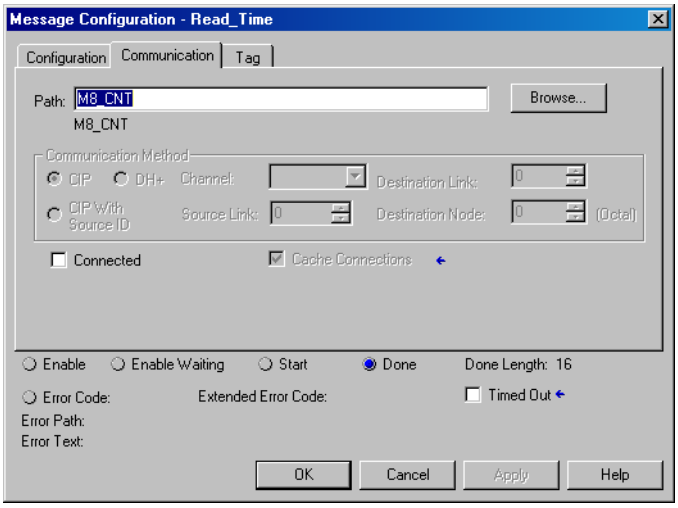


Message Setup Dialogs

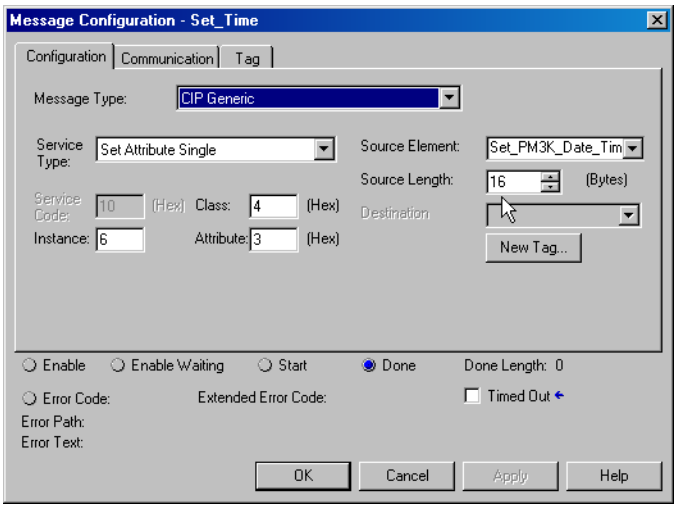
This is the Read message dialog:



The communications tab of the message setup simply shows the module name in the I/O configuration for this example.



The Write message dialog is similar to the Read:



Note that the source length is in Bytes, not elements. Since this message write 8 INT elements, the message length is 16 bytes.

RSLinx DDE/OPC and Microsoft Excel

You may create a simple data transfer application using RSLinx direct data exchange (DDE) capabilities and a DDE client such as Microsoft Excel™. This example uses DDE to read and write the value of the

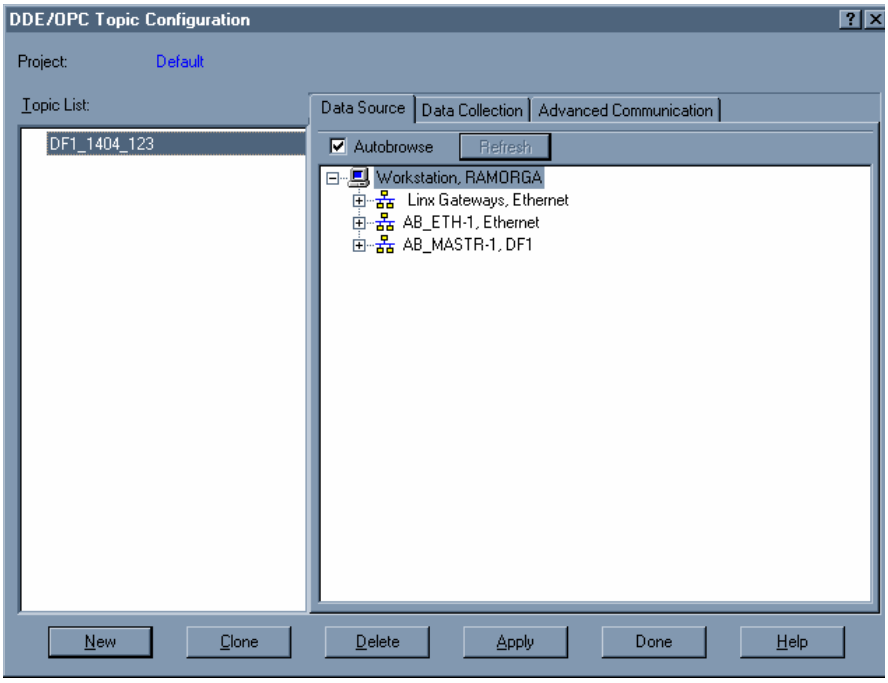
real-time clock in a Powermonitor 3000. You may utilize similar techniques to transfer data to and from any Powermonitor 3000 data tables.

Setting up a DDE topic in RSLinx

Follow these steps to create a DDE topic in RSLinx. You will need RSLinx OEM, Professional, Gateway or SDK to support DDE communications.

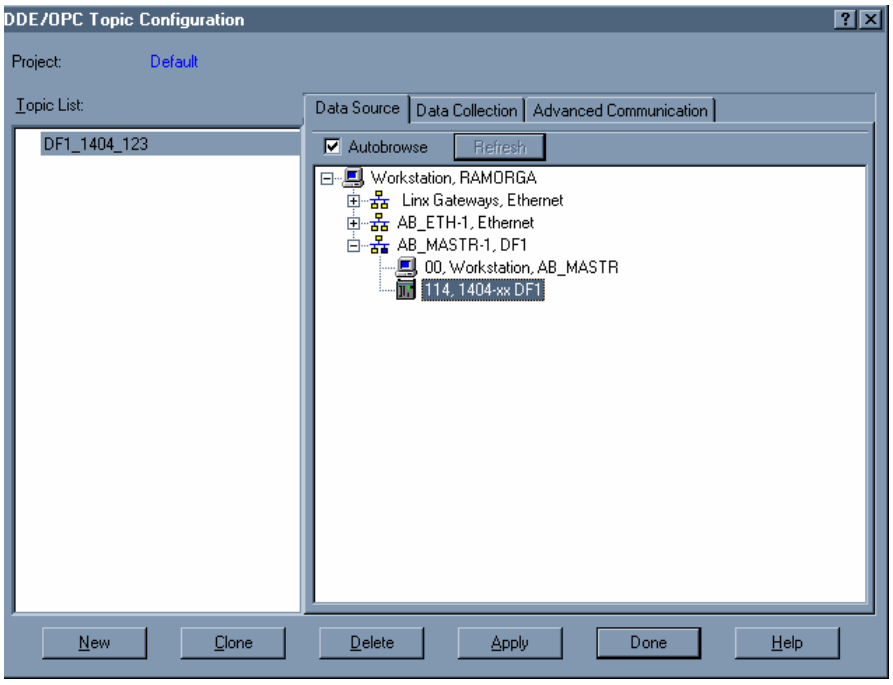
1. Establish communications between RSLinx and your Powermonitor using the communications method of your choice. The example uses the native DF1 communications port

2. In RSLinx, select *DDE/OPC* from the main menu

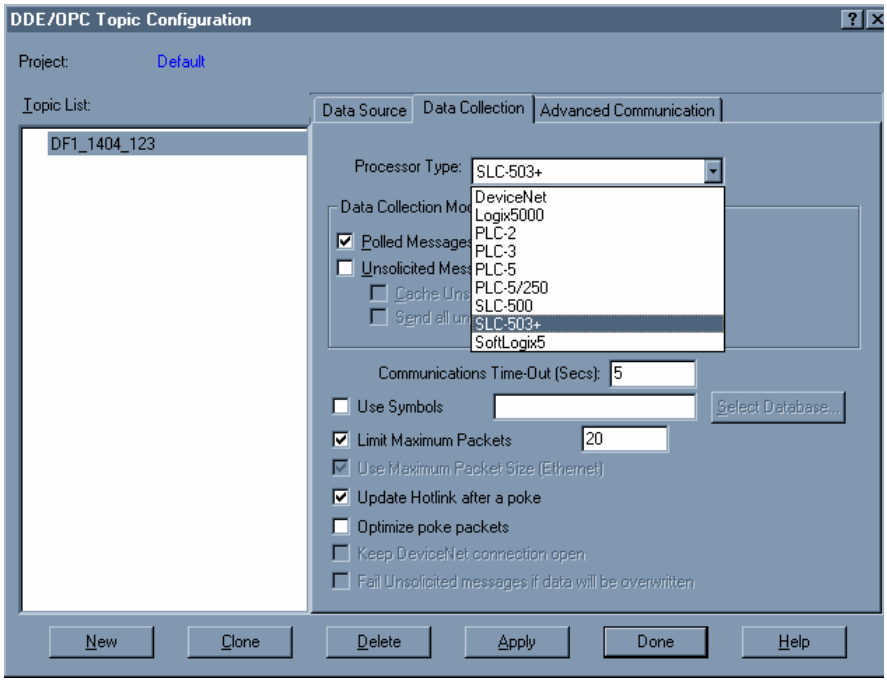


3. Click the *New* button. Enter a name for the DDE/OPC topic. The example uses DF1_1404_123.

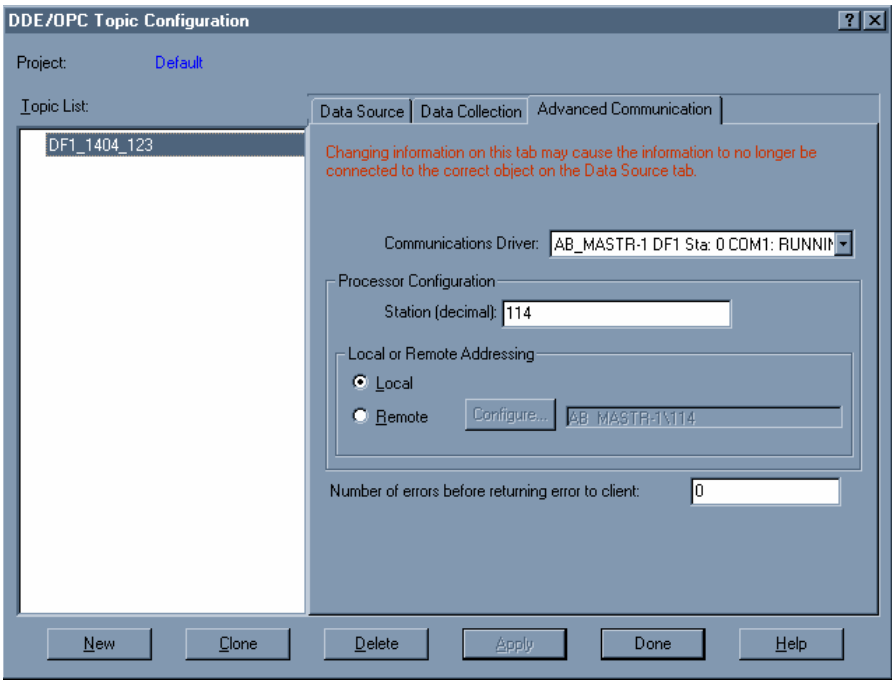
4. Browse through the tree in the Data Source window to locate your Powermonitor 3000. Click its icon to select it.



5. Click on the Data Collection tab. Select *SLC 5/03+* as the *Processor Type*. Leave the rest of the settings as default.

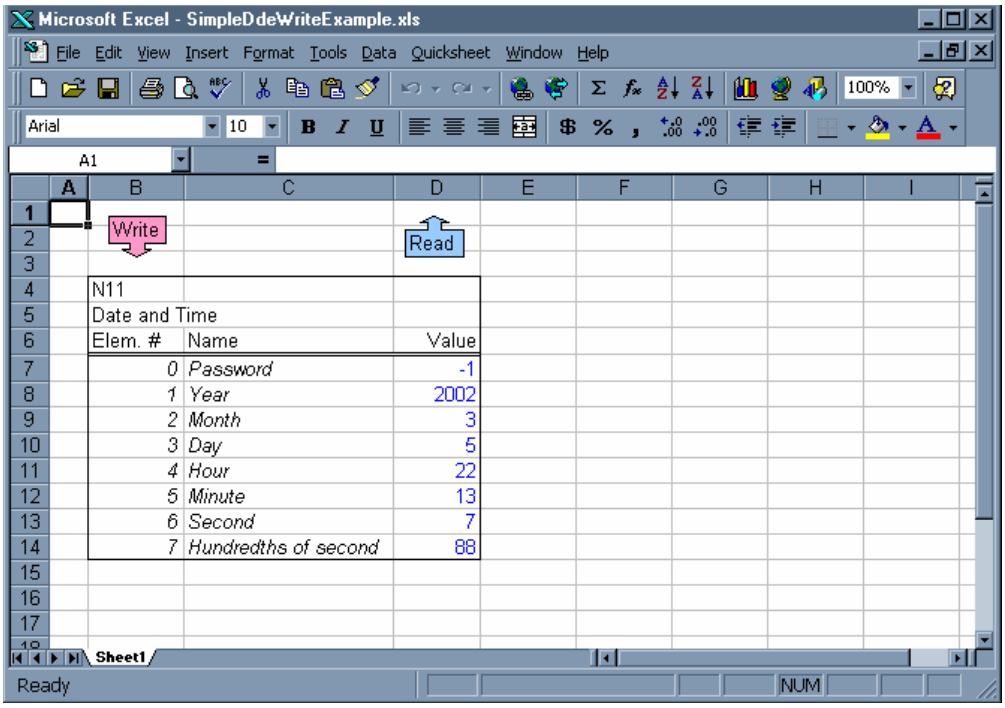


6. Click *Apply* and confirm when prompted. Click the *Advanced Communications* tab to verify the driver and path settings in the topic. Click the *Done* button.



The Microsoft Excel Sample Worksheet

The sample worksheet uses Visual Basic for Applications (VBA) macros to read and set the date and time in the Powermonitor 3000.



The range *Sheet1!D7:D14* is the write source range and the read target range. The *Read* graphic element is associated with the following VBA script or macro:

Sub ReadDateAndTime()

```
'Open DDE link; the first argument is the application we
'want to DDE with. Second argument is the DDE topic name
'configured in RSLinx
RSIchan = DDEInitiate("RSLINX", "DF1_1404_123")
'Read the date/time table from the PM3000 and put it in
'the excel sheet
Range("Sheet1!D7:D14") = DDERequest(RSIchan, "N11:0,L8")
'Close DDE link
DDETerminate (RSIchan)
```

End Sub

The *Write* graphic element is associated with the following VBA script:

Sub WriteDateAndTime()

```
'Open DDE link
RSIchan = DDEInitiate("RSLINX", "DF1_1404_123")
'Write data from the excel sheet into the PM3000
DDEPoke RSIchan, "N11:0,L8", Range("Sheet1!D7:D14")
'Close DDE link
DDETerminate (RSIchan)
```

End Sub

To read the date and time from the Powermonitor 3000, click the *Read* graphic element. To write the data and time to the Powermonitor 3000, enter the desired data and time into the worksheet along with the Powermonitor 3000 password (default = 0) and click the *Write* graphic element.

Date and Time Summary

You may use the examples above as building blocks to create applications to meet your business needs. Refer to Appendix A for detailed information on the Powermonitor 3000 data tables as well as the sections of this manual that describe the functionality you wish to include in your application.

Rockwell Automation also offers software products such as RSPower32 and RSEnergyMetrix that perform much of the data integration work for you. Please contact your Rockwell Automation representative for more information.

Multiple Data Table Reads Using DeviceNet

The following is a ladder program designed to return a number real-time data tables from a Powermonitor 3000 to an SLC 500 processor via DeviceNet using a DeviceNet scanner module. The following example and ladder diagram uses these settings:

- Node (MAC ID) = 5
- Port = 0
- Class = 4
- Instance = 14, 16, 18, 20, 22, 17, 25
- Attribute = 3
- Command = 1, 4
- Size 3
- Size = 3
- Service = 14

Explicit Message Transfer Setup

The Explicit Message Transfer Block header for this example is assembled in integer file N10:0. The header contains the information for all aspects of the transmission request. Each different node or instance requires assembling another file. Each file has to be moved in turn to the output M0 file starting at word 224.

Refer to *Devicenet Scanner Module Installation Instructions,* publication 1747-5.8, for a detailed description of all coding.

Table C.1

TXID	cmd/status
Port	Size
Service	MAC ID
Class	
Instance	
Attributes	

Word M0:1.224

A unique TXID (Transmit Identifier) and Command byte is needed for this word. The valid command codes are:

- 1 = Execute transaction block
- 4 = Delete transaction from response queue

A command byte of 1 is used first to start the explicit message. After a response has been received from the scanner, a command byte of 4 is used to remove this transaction from the scanner. If the command byte of 4 is not written to the SLC-500 DeviceNet Scanner, then it does not process further transactions.

Table 3.B

TXID		**Cmd**
TXID x 256	+	Cmd
20 x 256	+	1
5121		

Word M0:1.225

A port number and transaction body size is needed for this word. The port number is the DeviceNet scanner port that handles this transaction; an SLC-500 uses port 0 and the PLC-5 uses port 0 or 1. The size is the number of bytes (2 bytes = 1 word) in the transaction body which is 6 (6 bytes = 3 words).

Table 3.C

Port		Size	
	Port x 256	+	Size
	0 x 256	+	6
	6		

Word M0:1.226

A service code and MAC ID is needed for this word. The service code is the DeviceNet service that can be use on the Class 4 assembly instances; the valid service codes are:

- 14 = Get_Attributes_Single
- 16 = Set_Attributes_Single

The MAC ID is the node number of the device that the DeviceNet scanner is communicating to; this example uses node 5.

Table 3.D

Service		MAC ID	
	Service x 256	+	MAC ID
	14 x 256	+	5
	3589		

Word M0:1.227

The class number is the first word of the transaction body; class 4 is used to retrieve the real-time data assemblies.

Table 3.E

Class
4

Word M0:1.2278

The instance number is the second word of the transaction body; instance 14 is used to retrieve the real-time voltage, current, and frequency metering information.

Table 3.F

Instance
14

Word M0:1.229

The attribute number is the third word of the transaction body; attribute 3 is used to get the metering information.

Table 3.G

Attribute
3

SLC 500 Sequencer Operation

This example uses a sequencer instruction and indirect addressing to optimize program operation.

During initialization of Run mode, the sequencer input file is loaded with the numbers corresponding to the two explicit message transfers to be performed. Once Run mode has begun, the ladder program remains in this mode.

TIP The speed at which the processor performs the messages may be altered by resetting the On-Delay timer that is located within the sequencer output rung. However, the availability of new data values is controlled by the Powermonitor 3000 table update rate.

Data Files Used

Table C.8 Data Files

Data File Address	Number of Elements	Description
N9	1	N9:0 Sequencer Output
N10	Variable	N10:0 Sequencer Input
R6:0		Sequencer Control
Message Read Data Table Locations		
(Control/Data)		
N20 / F30	14	Voltage/Current Data
N21 / F31	13	Real-Time Power
N22 / F32	13	Power Factor
N23 / N33	23	KWh and KVAh
N24 / N34	23	KVarh
N25 / F35	10	Demand
N26 / N36	27	Diagnostic

The reset word for the sequencer is N10:0. The first word in the rotation of the sequencer is N10:1. The value in N10:0 must be the same as that in N10:1. The size of file N10 is equal to the size of the largest sequencer input file. This size depends on the number of explicit message transfers to be performed. The sequencer length may be expanded or reduced for run mode. It is imperative that the corresponding file that serves as the source of the sequencer's input file, N10, must be modified accordingly.

IMPORTANT Failure to modify the length of file N10 for a modification of either the Configuration or Run sequence results in improper operation of the ladder program, and possible FAULT of the processor due to invalid indirect offsets.

File Data Values

Prior to running the sample ladder, the sequencer initialization file needs to be loaded with the numbers that correspond to the explicit message transfer sequence. The following is a list of each mode's initialization file and the required/possible numbers to be stored in

each. The first value of a block transfer sequence must be duplicated in both position 0 and 1 of an initialization file.

N10 - Run Mode

Required numbers are 20, 20, 21, 22, 23, 24, 25, and 26.

N20:0

Required numbers are 5121, 6, 3589, 4, 14, 3

N21:0

Required numbers are 5377, 6, 3589, 4, 16, 3

N22:0

Required numbers are 5633, 6, 3589, 4, 18, 3

N23:0

Required numbers are 5889, 6, 3589, 4, 20, 3

N24:0

Required numbers are 6145, 6, 3589, 4, 22, 3

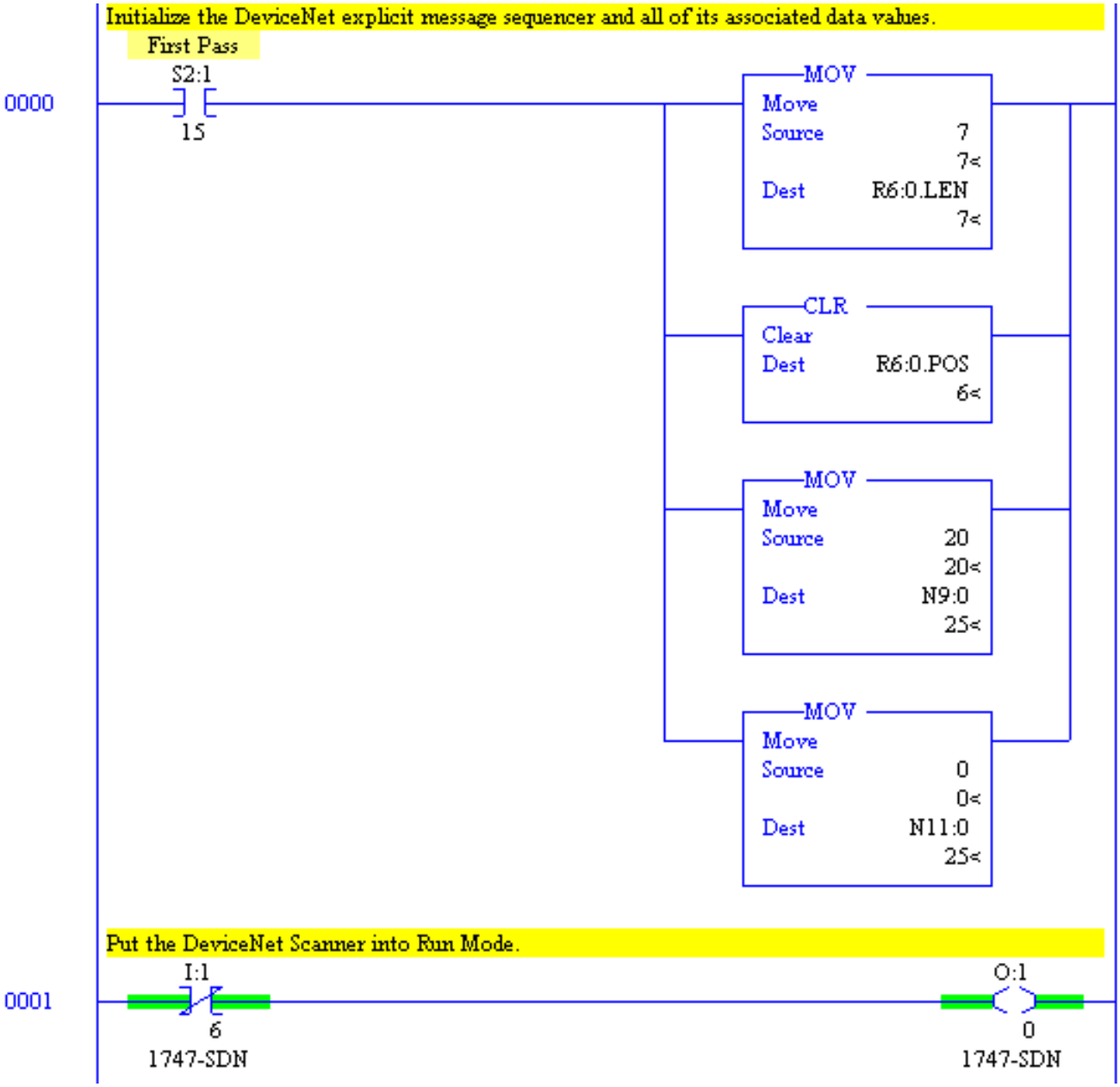
N25:0

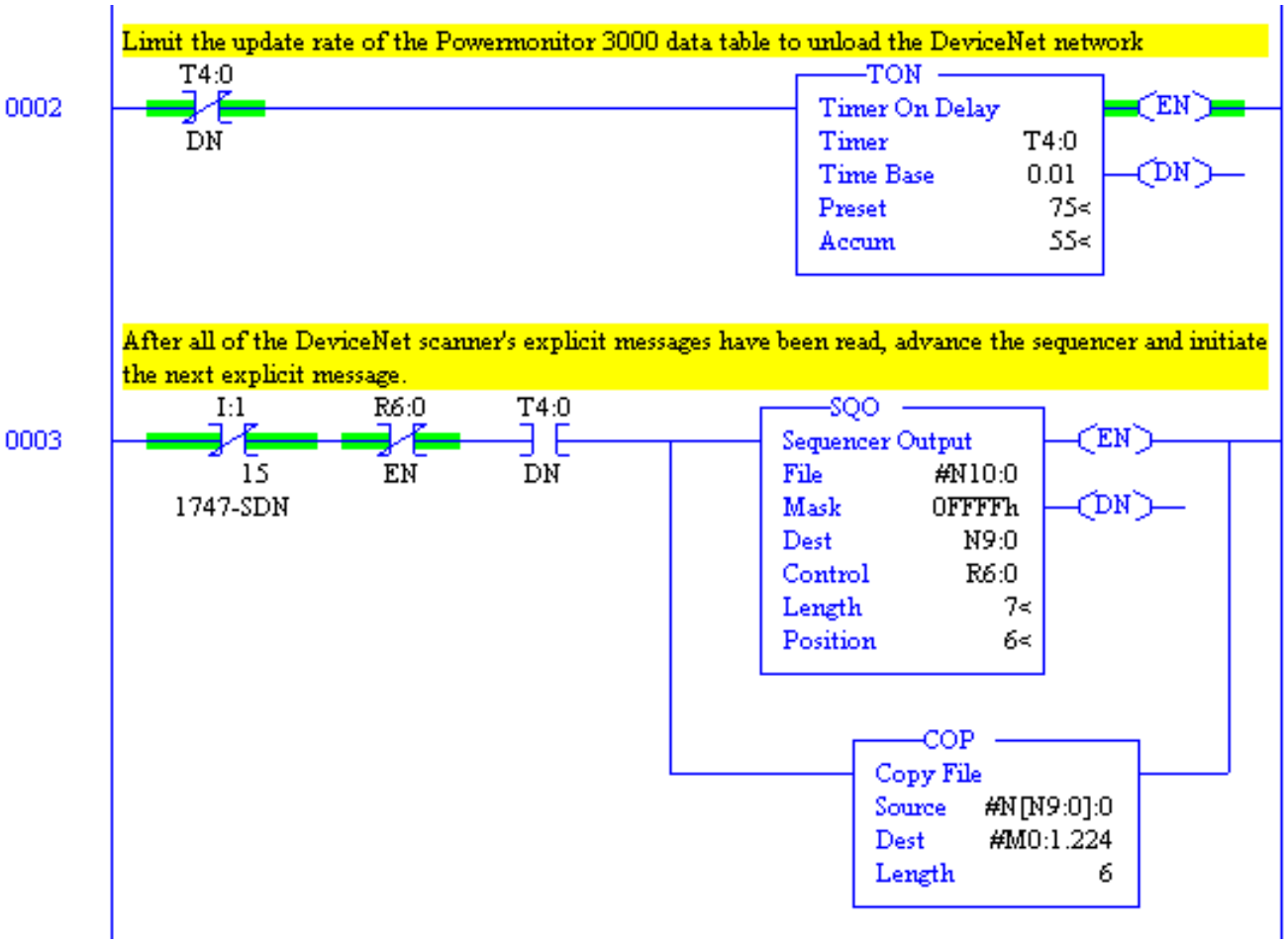
Required numbers are 6401, 6, 3589, 4, 17, 3

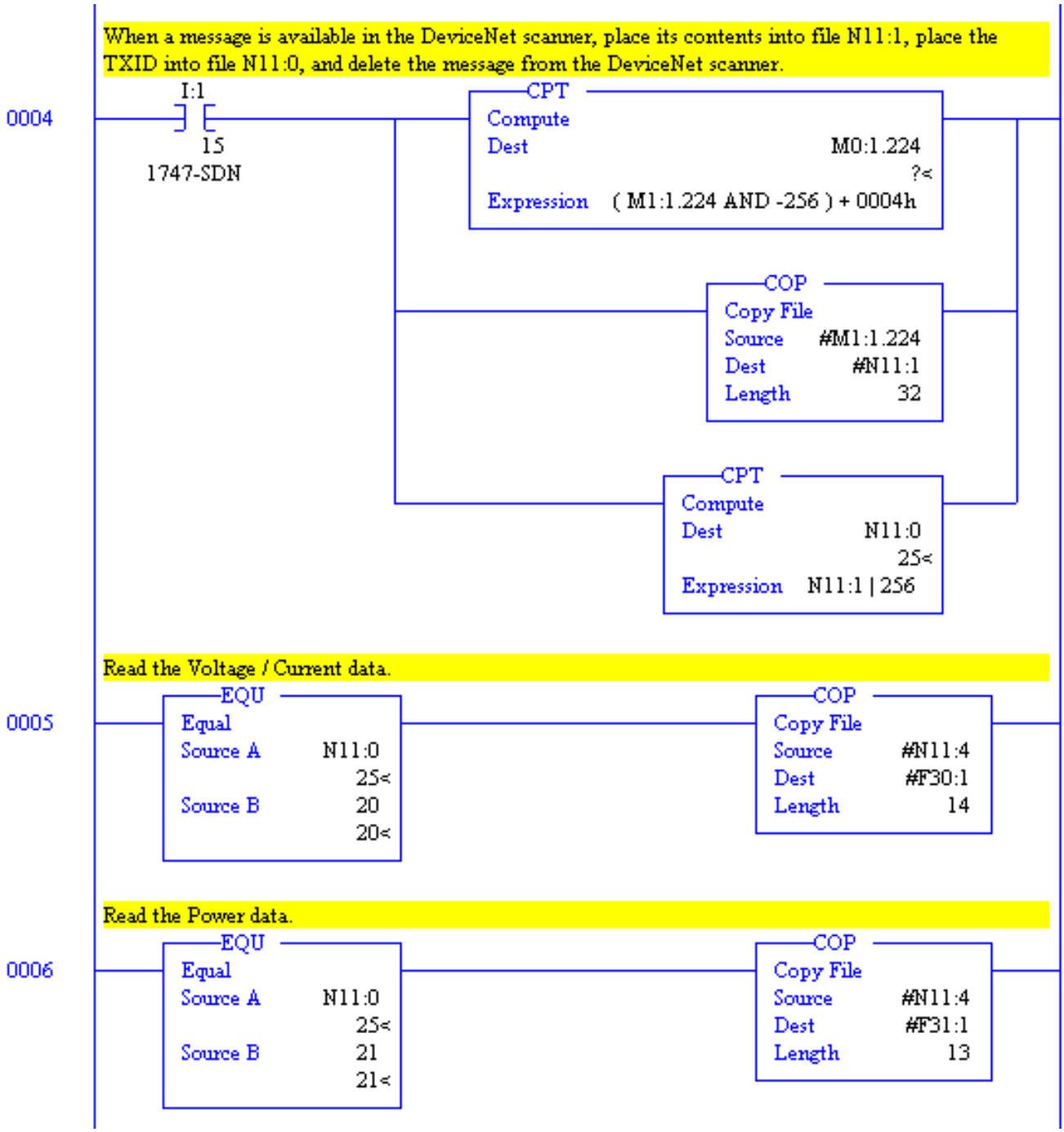
N26:0

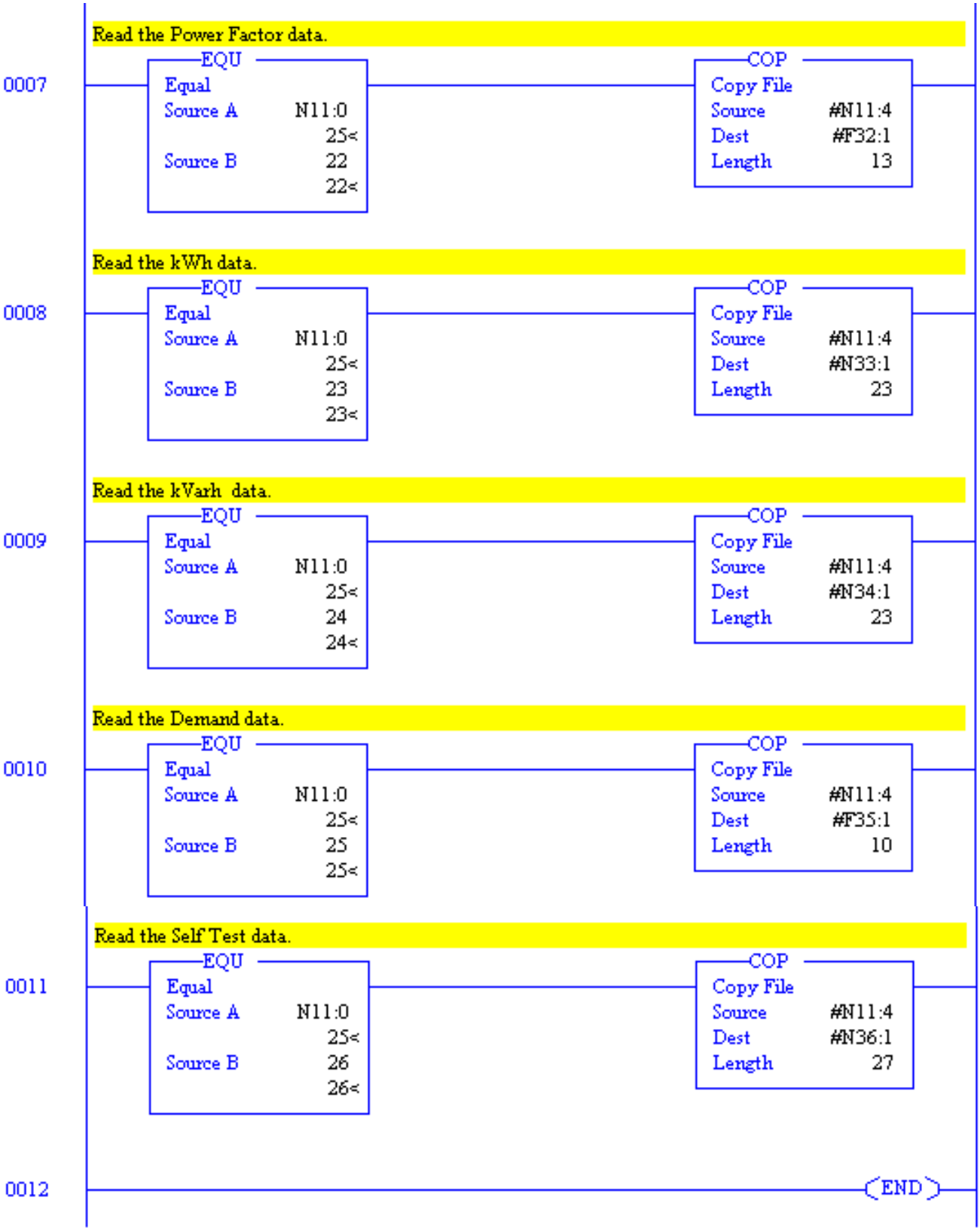
Required numbers are 6657, 6, 3589, 4, 23, 3

Ladder Diagram




Limit the update rate of the Powermonitor 3000 data table to unload the DeviceNet network
0002
T4:0
DN
TON
Timer On Delay
Timer T4:0
Time Base 0.01
Preset 75<
Accum 55<
EN
DN
After all of the DeviceNet scanner's explicit messages have been read, advance the sequencer and initiate the next explicit message.
0003
I:1
15
1747-SDN
R6:0
EN
T4:0
DN
SQO
Sequencer Output
File #N10:0
Mask 0FFFFh
Dest N9:0
Control R6:0
Length 7<
Position 6<
EN
DN
COP
Copy File
Source #N[N9:0]:0
Dest #M0:1.224
Length 6


When a message is available in the DeviceNet scanner, place its contents into file N11:1, place the TXID into file N11:0, and delete the message from the DeviceNet scanner.
0004
I:1
15
1747-SDN
CPT
Compute
Dest M0:1.224
?<
Expression (M1:1.224 AND -256) + 0004h
COP
Copy File
Source #M1:1.224
Dest #N11:1
Length 32
CPT
Compute
Dest N11:0
25<
Expression N11:1 | 256
Read the Voltage / Current data.
0005
EQU
Equal
Source A N11:0
25<
Source B 20
20<
COP
Copy File
Source #N11:4
Dest #F30:1
Length 14
Read the Power data.
0006
EQU
Equal
Source A N11:0
25<
Source B 21
21<
COP
Copy File
Source #N11:4
Dest #F31:1
Length 13


Read the Power Factor data.
0007
EQU
Equal
Source A N11:0
25<
Source B 22
22<
COP
Copy File
Source #N11:4
Dest #F32:1
Length 13
Read the kWh data.
0008
EQU
Equal
Source A N11:0
25<
Source B 23
23<
COP
Copy File
Source #N11:4
Dest #N33:1
Length 23
Read the kVarh data.
0009
EQU
Equal
Source A N11:0
25<
Source B 24
24<
COP
Copy File
Source #N11:4
Dest #N34:1
Length 23
Read the Demand data.
0010
EQU
Equal
Source A N11:0
25<
Source B 25
25<
COP
Copy File
Source #N11:4
Dest #F35:1
Length 10
Read the Self Test data.
0011
EQU
Equal
Source A N11:0
25<
Source B 26
26<
COP
Copy File
Source #N11:4
Dest #N36:1
Length 27
0012
END

User-Configured Data Table Setup Using ControlLogix and EtherNet/IP

The final example is a ladder program designed to customize the User Configured Data Table in a Powermonitor 3000 using a ControlLogix controller via its EtherNet/IP Bridge (1756-ENET/B).

Use of the user-configured data table to consolidate parameters from different Powermonitor 3000 data tables can increase the efficiency of communications. The following example and ladder listing use these settings:

- IP Address: 130.151.70.173
- Subnet mask: 255.255.0.0
- Gateway IP Address: Not Set
- Keep Alive Time: 30 Seconds
- Message type: PLC-5 Typed Read

Sample Program Operation

The ladder program is executed within a continuous task. This sample logic reads and saves the existing User Configured Data Table setup file from the Powermonitor 3000 to permit an “Undo” operation. The user must create tags listed in Table C.9 below and enter data correctly to configure the Powermonitor 3000 User Configurable Data Table successfully.

The “Start” flag begins the logic execution. The “Select” tag’s value determines which configuration is written to the Powermonitor 3000.

- 0 - Default table setup
- 1 - Custom table setup
- 2 - Undo the last write

First, the logic reads the existing setup table from the Powermonitor 3000 and saves it in the “Old” tag. After a brief delay, it writes the selected setup table. If the number of parameters in the User Configured Data Table changes, the Powermonitor 3000 resets. After another delay, the write status table is read and if it indicates a successful write, the “Success” flag is set.

The message configuration for writing the new configuration table to the Powermonitor 3000 is shown below. Note the instance name is the lower of the two values given in Table A.1. Service code 10 (hex) is for a write “Set_attribute_single”.

Table C.9 ControlLogix Tags Used

Tag Name	Type	# of Elems	Description	Table #
msgReadOld	MESSAGE	N/A	Read Existing Config	N30
msgWriteNew	MESSAGE	N/A	Write New Config.	N30
msgGetStatus	MESSAGE	N/A	Write Status	N32
Start	BOOL	1	Start Operation	
Failed	BOOL	1	Failure Flag	
Success	BOOL	1	Success Flag	
Oneshot_1	BOOL	1	One shot	
Oneshot_2	BOOL	1	One shot	
Timer1	TIMER	1	Inter-message Delay	
Timer2	TIMER	1	PM3000 Reset Time	
Counter1	COUNTER	1	Message Retry	
Default	INT	26	Default Configuration	
Custom	INT	26	Custom Configuration	
Old	INT	26	Previous Config	
Download	INT	26	New Config to Write	
Pwd	INT	1	PM3000 Password	
Status	INT	2	Write Status	
Select	INT	1	User Selection	

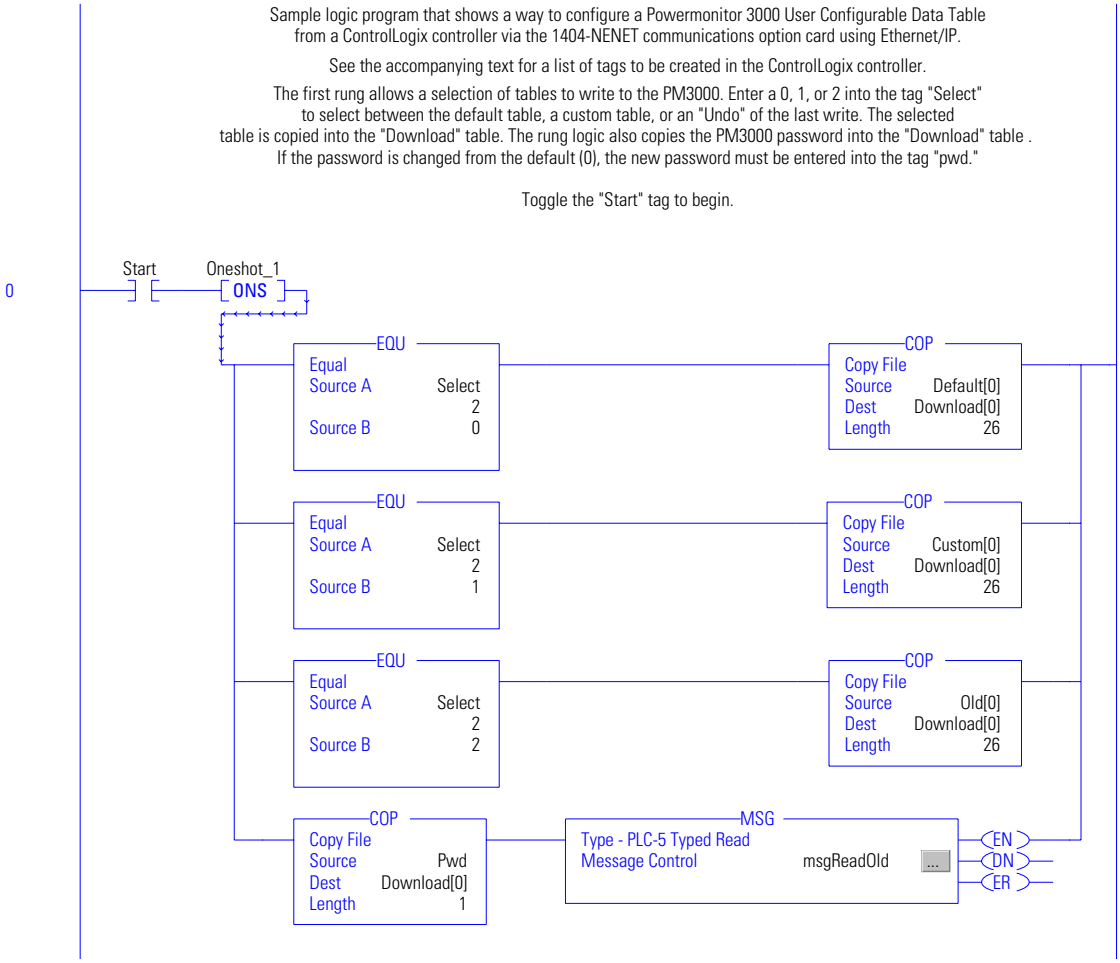
The user must enter data into the “Default” and “Custom” tags. Refer to User-Configured Data Table on page 4-53 for the structure and rules for the User Configured Table Setup data table and its default settings.

See Table A.59 on page A-69 for parameters which may be included in the User Configured Table Setup.

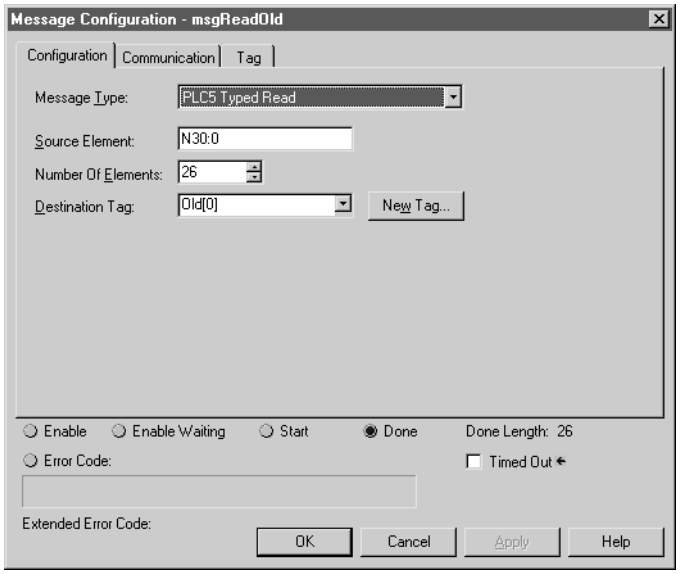
IMPORTANT Words 0 through 3 of the User Configurable Table Setup array must have specific values.

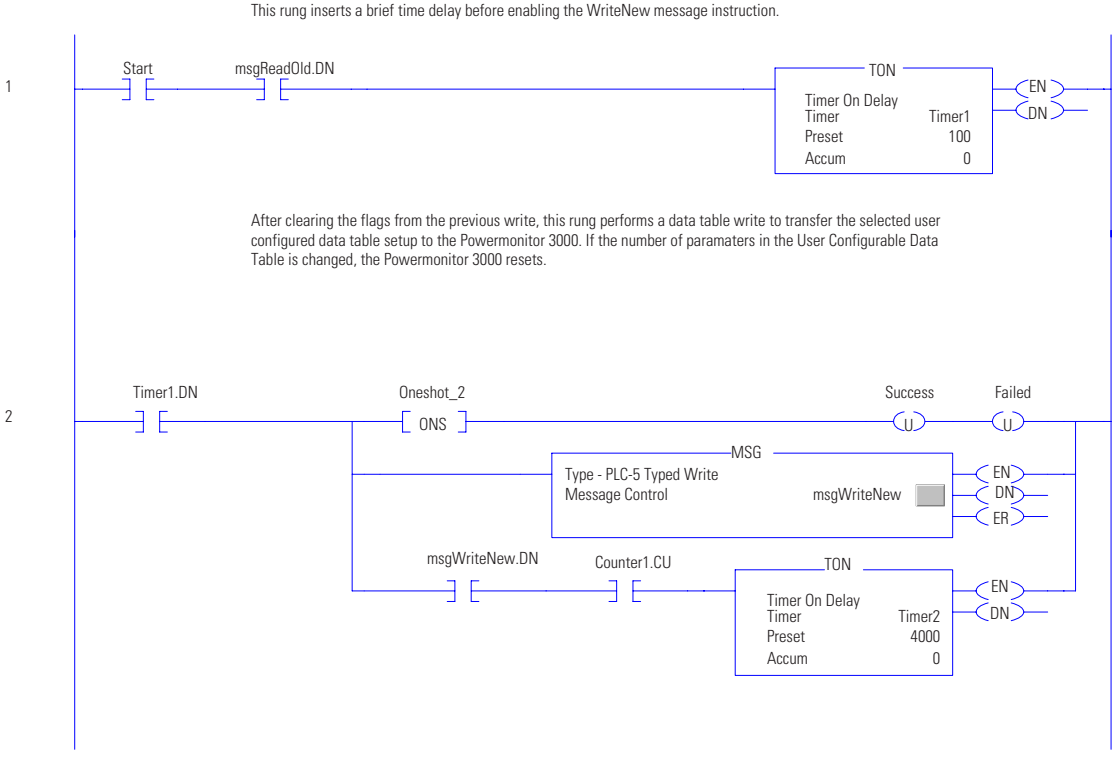
- Word 0: Powermonitor 3000 password (default = 0)
- Word 1 must be one of the following decimal values:
  - 31, for CSP/PCCC Typed Write
  - 1 or 37 for CIP Set Attr Single
- Word 2: zero (0) for writes to table 31 (37). For configuring instance 1: 0 = all integer table (instance 1) data type, 1 = all float table (instance 1) data type.
- Word 3: between 1 and 295 incl.

Ladder Diagram

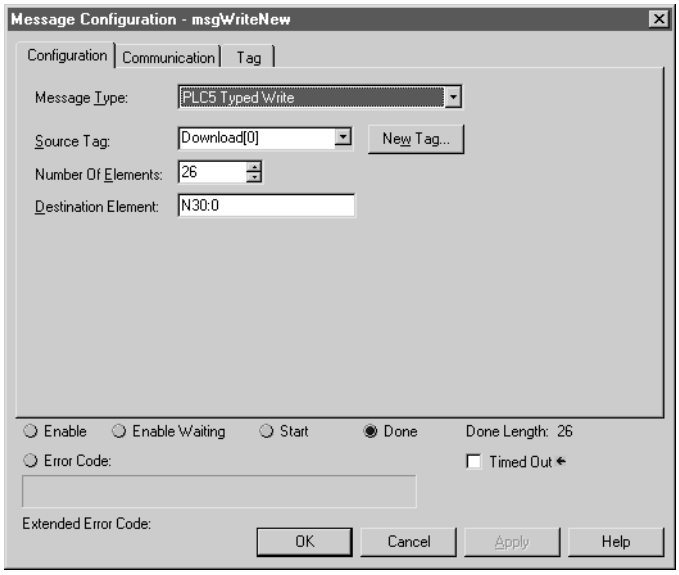


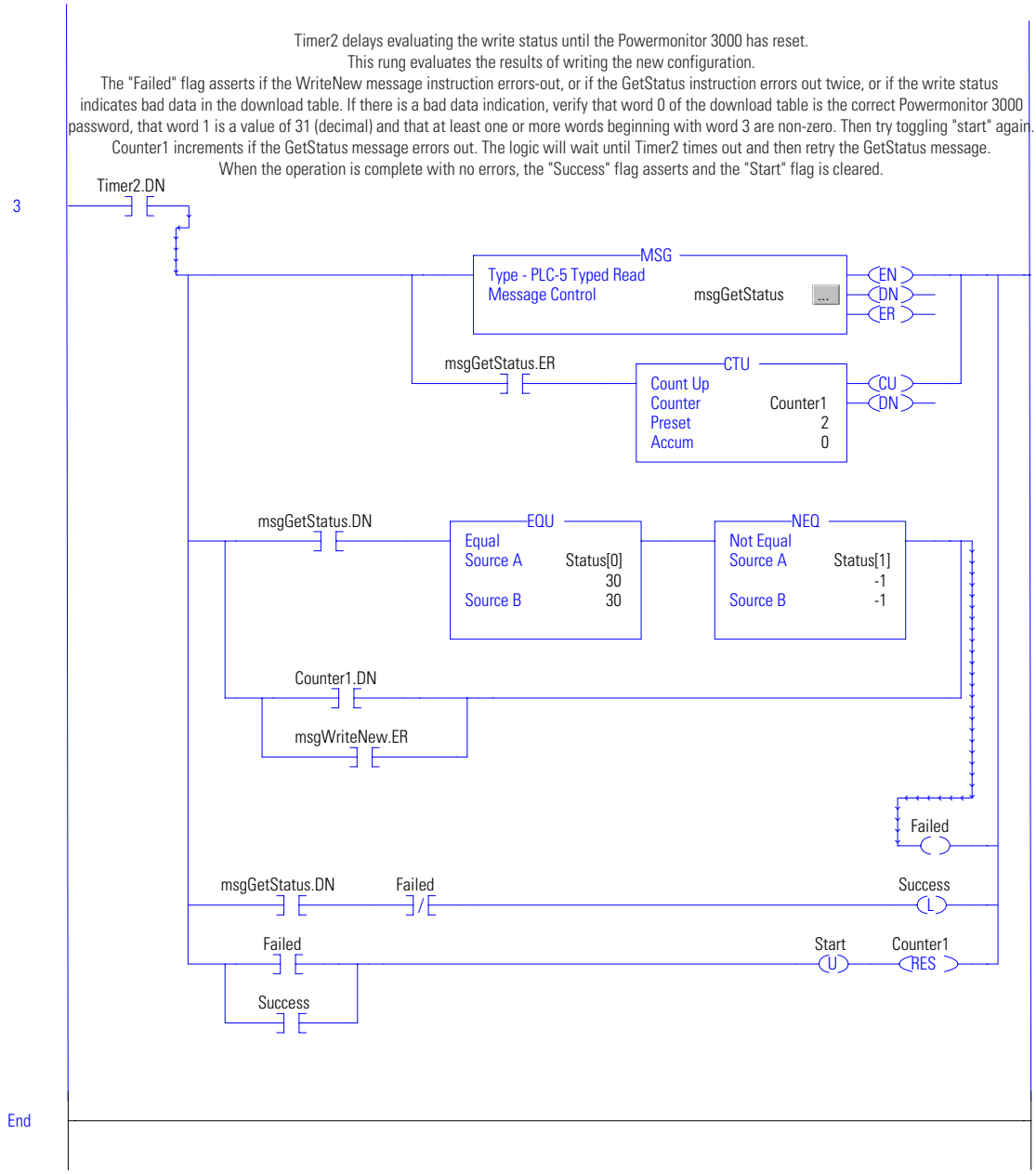
The message configuration for the ReadOld message is shown below.



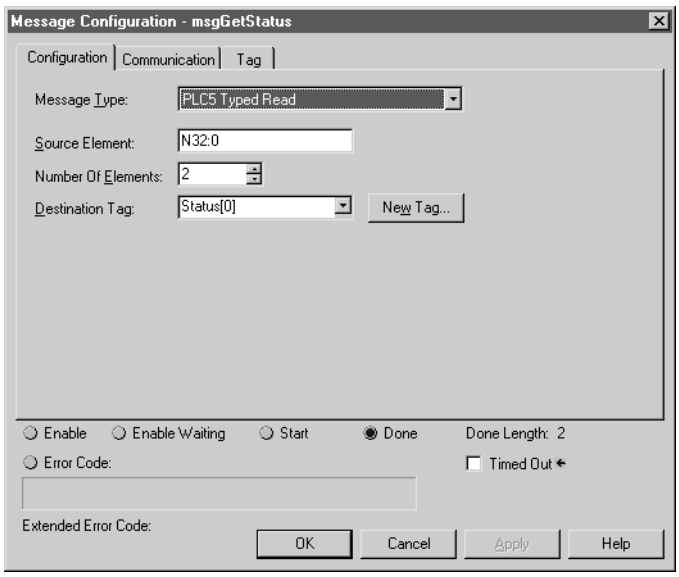


The message configuration for writing the new configuration table to the Powermonitor 3000 is shown below.


Message Configuration - msgWriteNew
Configuration
Communication
Tag
Message Type:
PLC5 Typed Write
Source Tag:
Download[0]
New Tag...
Number Of Elements:
26
Destination Element:
N30:0
Enable
Enable Waiting
Start
Done
Done Length: 26
Error Code:
Timed Out
Extended Error Code:
OK
Cancel
Apply
Help



The message configuration for the GetStatus message is shown below.



Communicating with a SLC5/05 (1747-L552) Controller and ControlNet Scanner (1747-SCNR), Unscheduled Messaging

The Power Energy and Management Systems development team tested the following example ladder. The scan times for execution of the ladder are as follows.

Table C.10

Operation	Scan Time
Table reads for Integer and float files	20 ms
Table writes of Integer and float files	30 ms

All the communication operations of the ladder are locked out until the read or write bits are set. This was done so that other operations performed by the ladder will have minimum overhead from communications. The following files are of importance when using the ladder example.

N7 SCNR_FILE

The following items are of importance in file N7:0:

Table C.11

Bit #	Importance N7:0	Read/Write
N7:0/15	EN - Written to by the ladder to enable communication transaction.	R/W
N7:0/14	Unused	N/A
N7:0/13	DN bit - Response received	R
N7:0/12	ER bit - Error bit returned form SCNR scanner	R
N7:0/11	CO - Continuous mode Not used	N/A
N7:0/10	EW - Message taken into account by 1747 - SCNR scanner	R
N7:0/9	SUCCESS - Used by ladder for notification of successful communication transfer.	R
N7:0/8	TO - The message transaction has timed out.	R

While other words in the N7 SCNR_FILE are important to communications these values are copied from file N9 CIP_SETUP to file N7.

N9 CIP_SETUP

This file is the CIP message setup file. The importance of the following words should be noted.

Table C.12

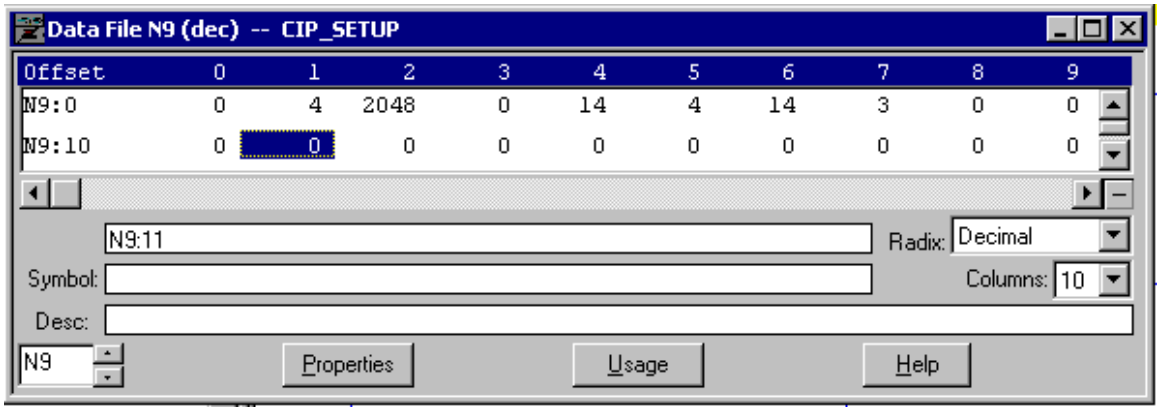
Word #	Description of Function
N9:0	Not used by CIP_SETUP.
N9:1	Target MAC ID (Power monitor MAC ID)
N9:2	Communication transaction timeout setting in ms. (2048 recommended)
N9:3	Complex IOI size. Not used and set to 0.
N9:4	Service code. 0xE for Get Attribute Single or 0x10 Set Attribute single.
N9:5	Class code of Instance Object. Power monitor class 4 assembly instance.(4)
N9:6	Targets Instance number to read or write.
N9:7	Target Attribute. Power monitor Attribute of assembly instance is 3. (3)
N9:8	Target member number. (Not used)

Table C.12

Word #	Description of Function
N9:9	Size of the data in words. Used for writes only. When performing a read operation this parameter is forced to 0. Size of Power monitor tables is type N = elements x 1, type F = elements x 2.
N9:10	Not used by CIP_SETUP.
N9:11	Enables a read/write operation. Writing a 1 starts the process for writing an assembly instance of the power monitor. Writing a 2 starts the read process of assembly instance from the power monitor.

Receiving Information from the SCNR Scanner

Observe the sample of the CIP_SETUP file for the retrieval of VIF table assembly instance 14 of the power monitor.

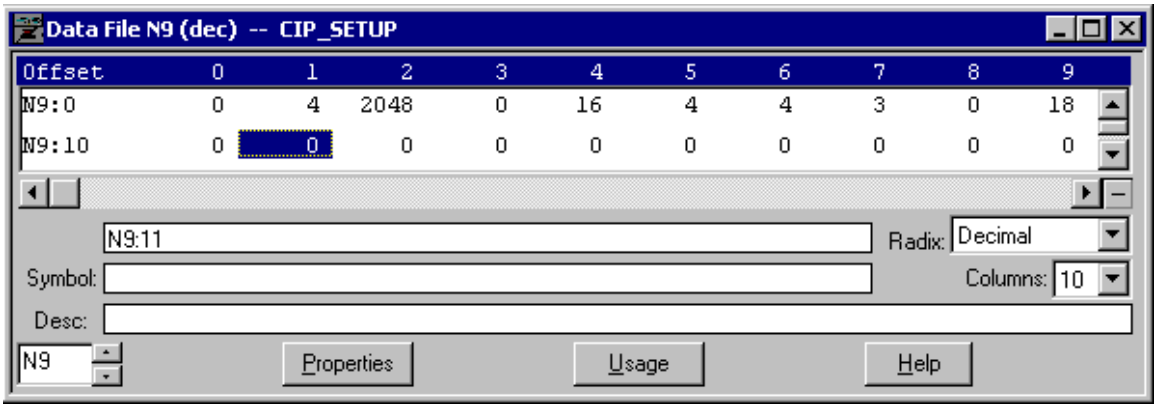


After setting up the communication parameters a 2 is written to location of N9:11. The transaction is complete when bit N7:0/9 becomes true. The information will be located in file F8, FLT_DATA starting at location 0. The length of usable information is the length of elements in table instance 14 VIF table of the power monitor.

TIP When receiving integer information from the power monitor the data will be readable from file number N10 INT_DATA. The length is the number of elements in the assembly instance being read.

Writing Information through the SCNR Scanner

Observe the sample of the CIP_SETUP file for the writing the configuration of the basic configuration table Instance 4 of the power monitor.



TIP

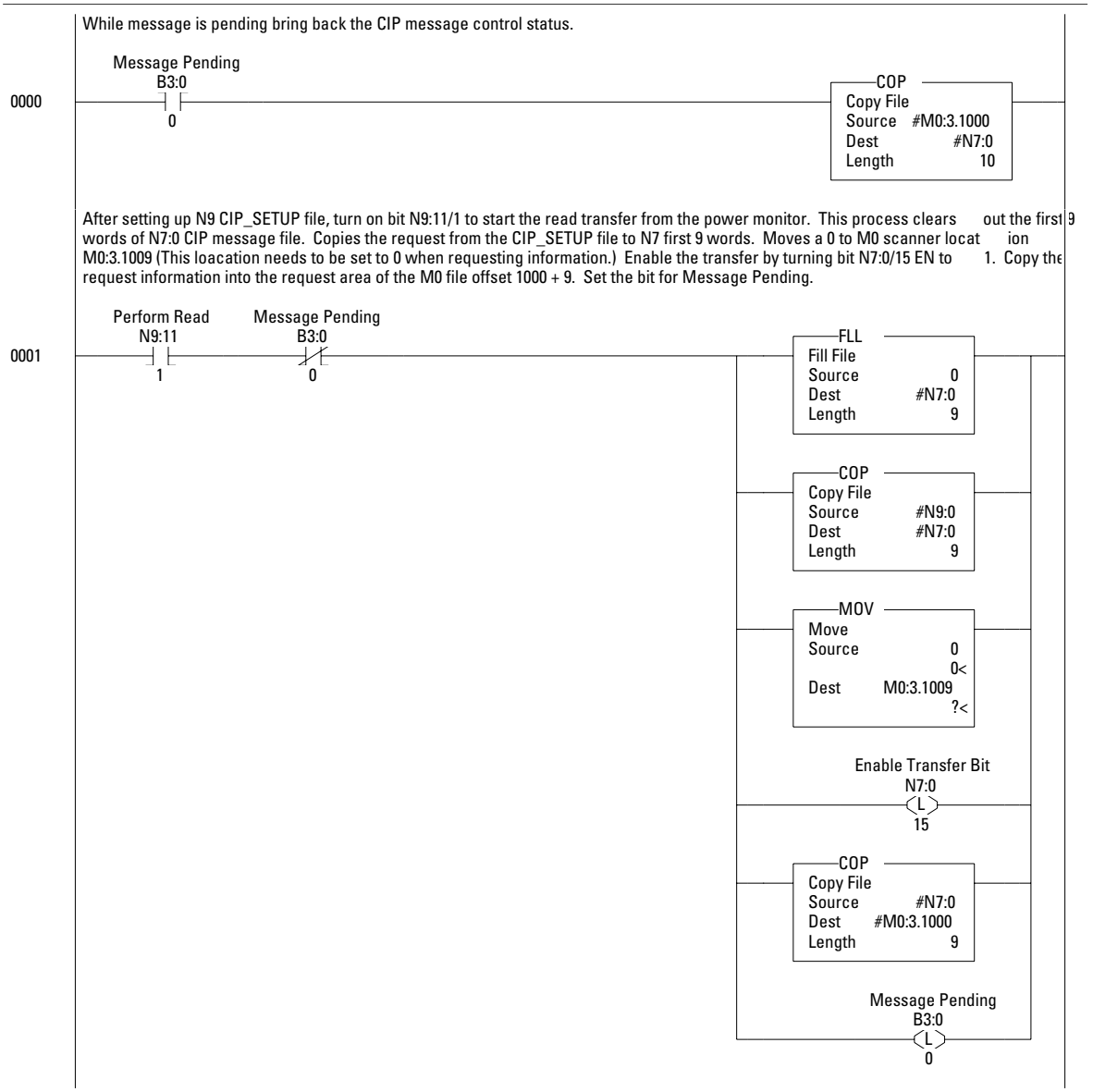
The write procedure differs slightly from the read process. N9:4 service has been changed to 0x10 or 16 decimal (Set Single Attribute). N9:6 is the write instance assembly number of the power monitor basic configuration table. N9:9 is the size of the table in words for a 1404-M805A-CNT A. The size for float tables is 2 times the number of elements. Integer tables are 1 times the size of the table elements.

When a 1 is written to location N9:11 the contents of file F13 WR_TRANSFR are sent to the power monitor. In this case starting with float F13:0 through F13:8.

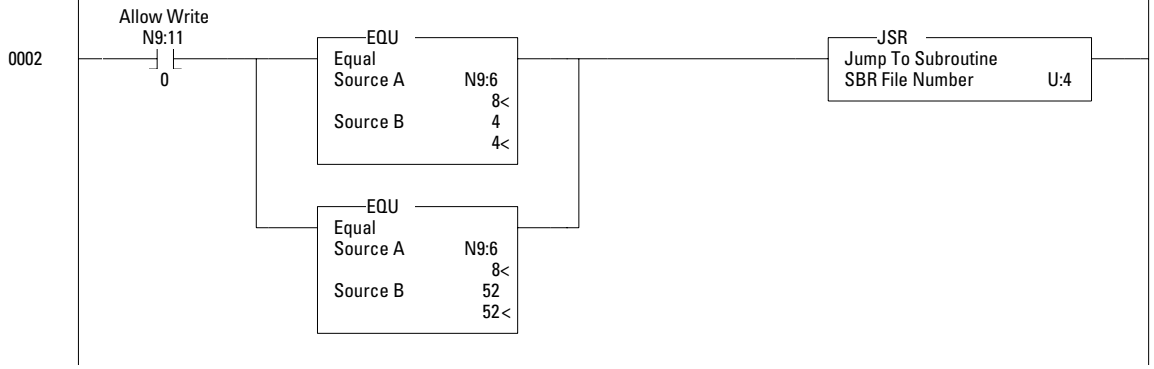
The writing of an integer file sends the contents of N14 WR_TRANSFR.

For further reading on the functionality of the 1747-SCNR scanner refer to user manual Publication 1747-RM623B-EN-P.

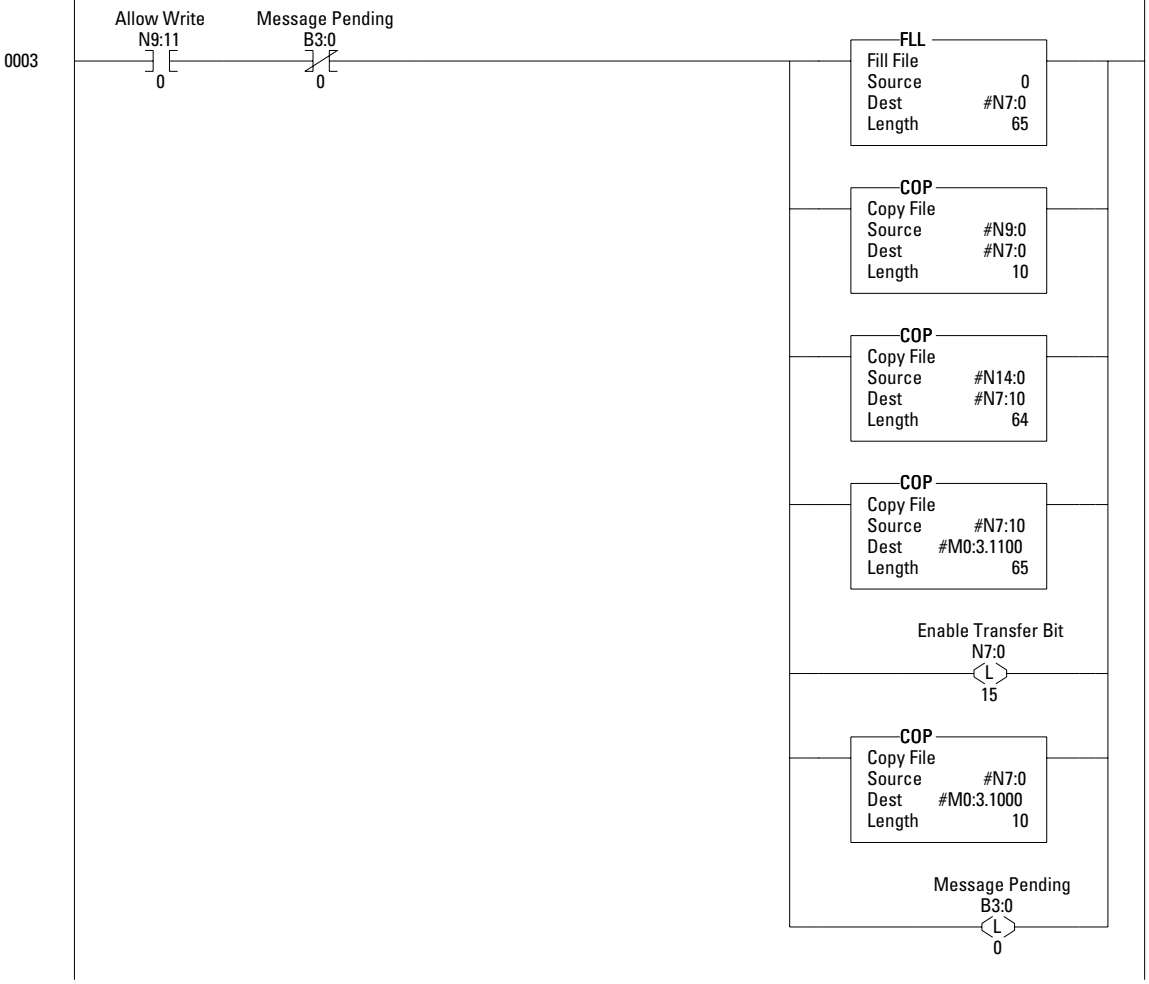
Powermonitor 3000 Ladder Example for SLC through SCNR



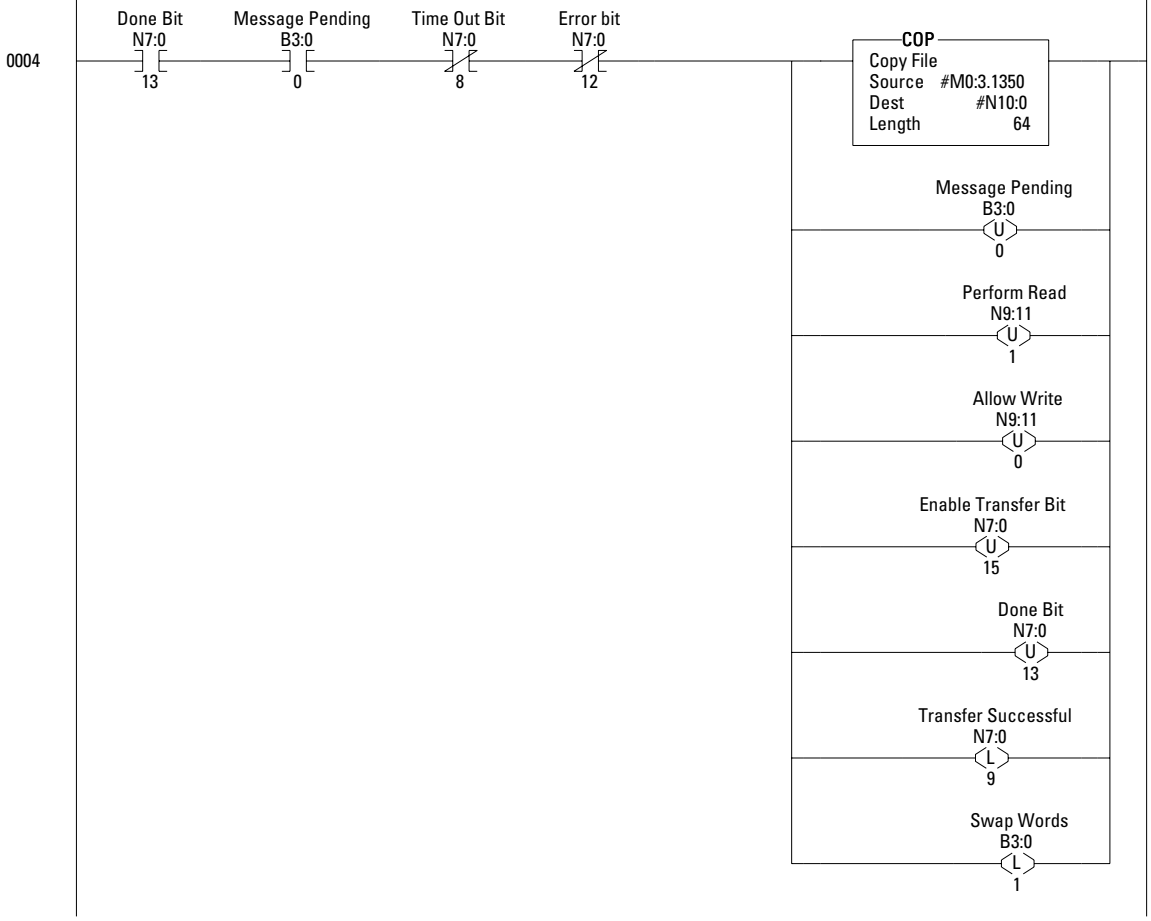
When a write of a float file is being performed it is necessary to swap the words in the float file before sending the write re quest. This is o nly necessary for Instance 4 or Instance 52.

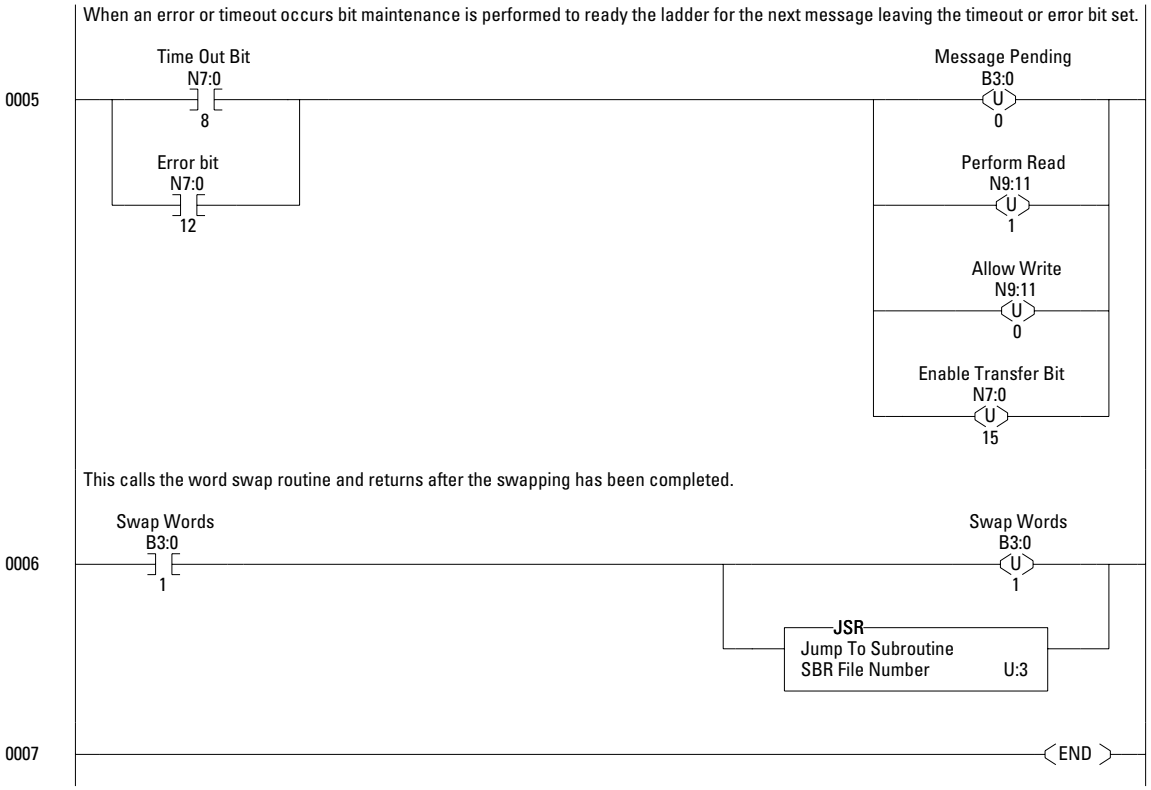


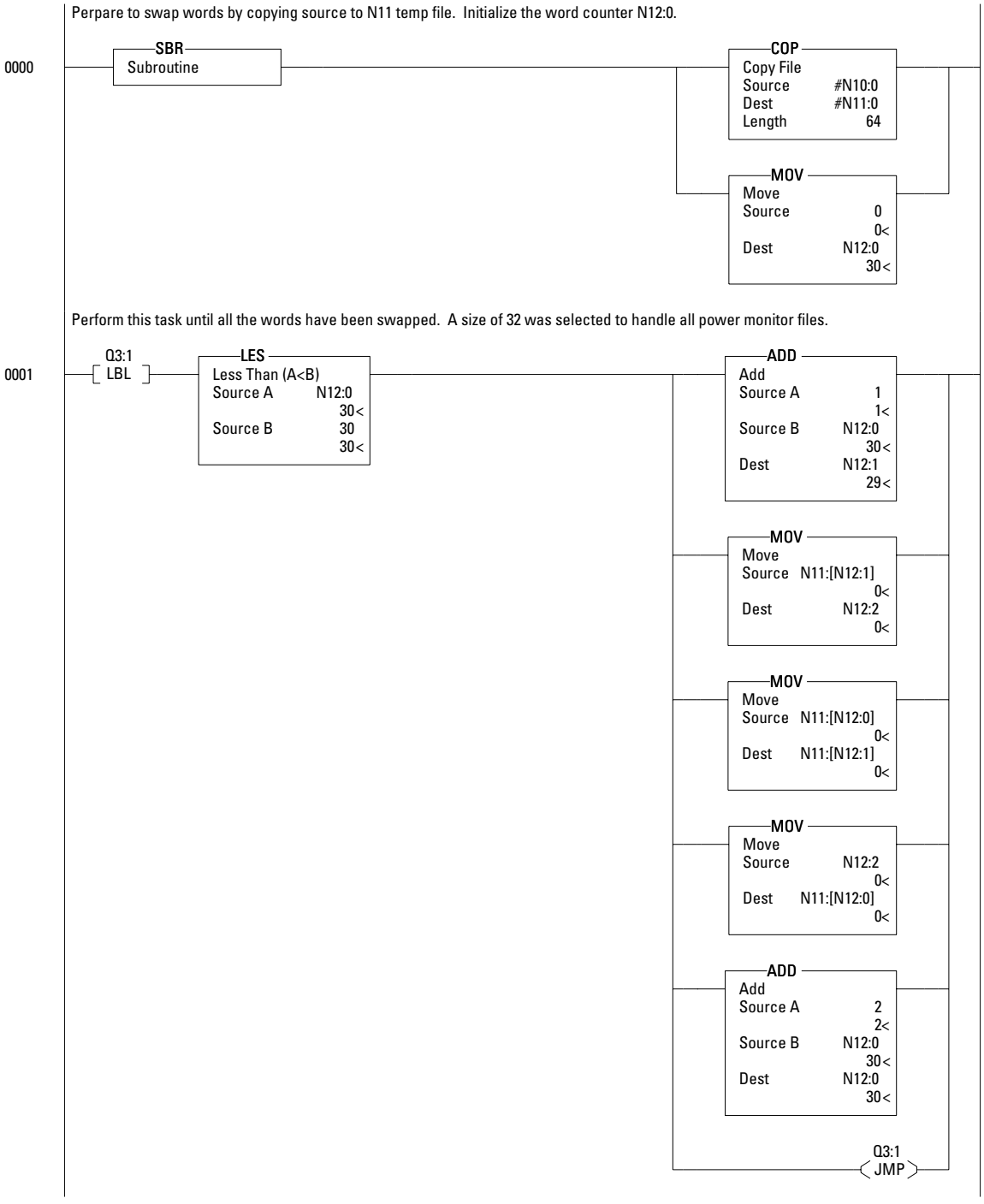
Allow the scanner to write to the power monitor. Put the new integer configuration data in N14 starting at location 0. Put the configuration if it is of float type in file F13 starting with word 0. Enter the rest of the CIP message information needed for transfer in N9 starting with word 0. The process is similar to the request of information except that the size in words of the data to write is to appear in N7:9 and the service to be performed is changed.

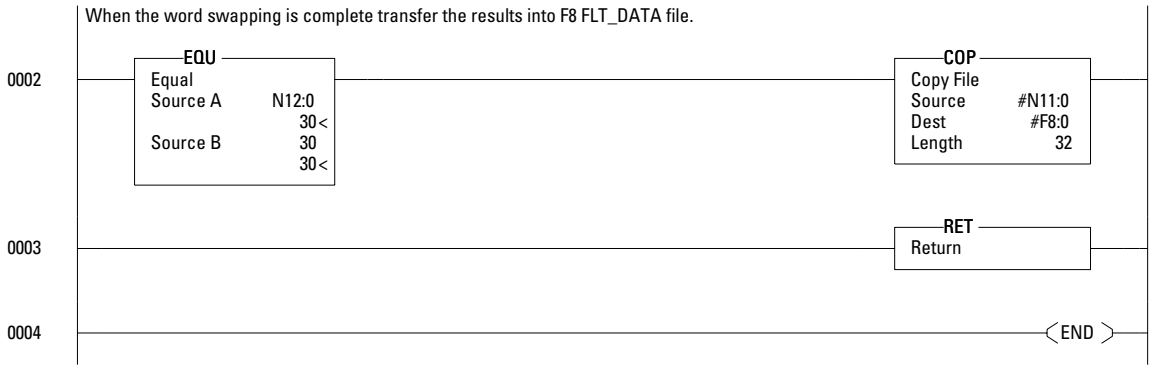


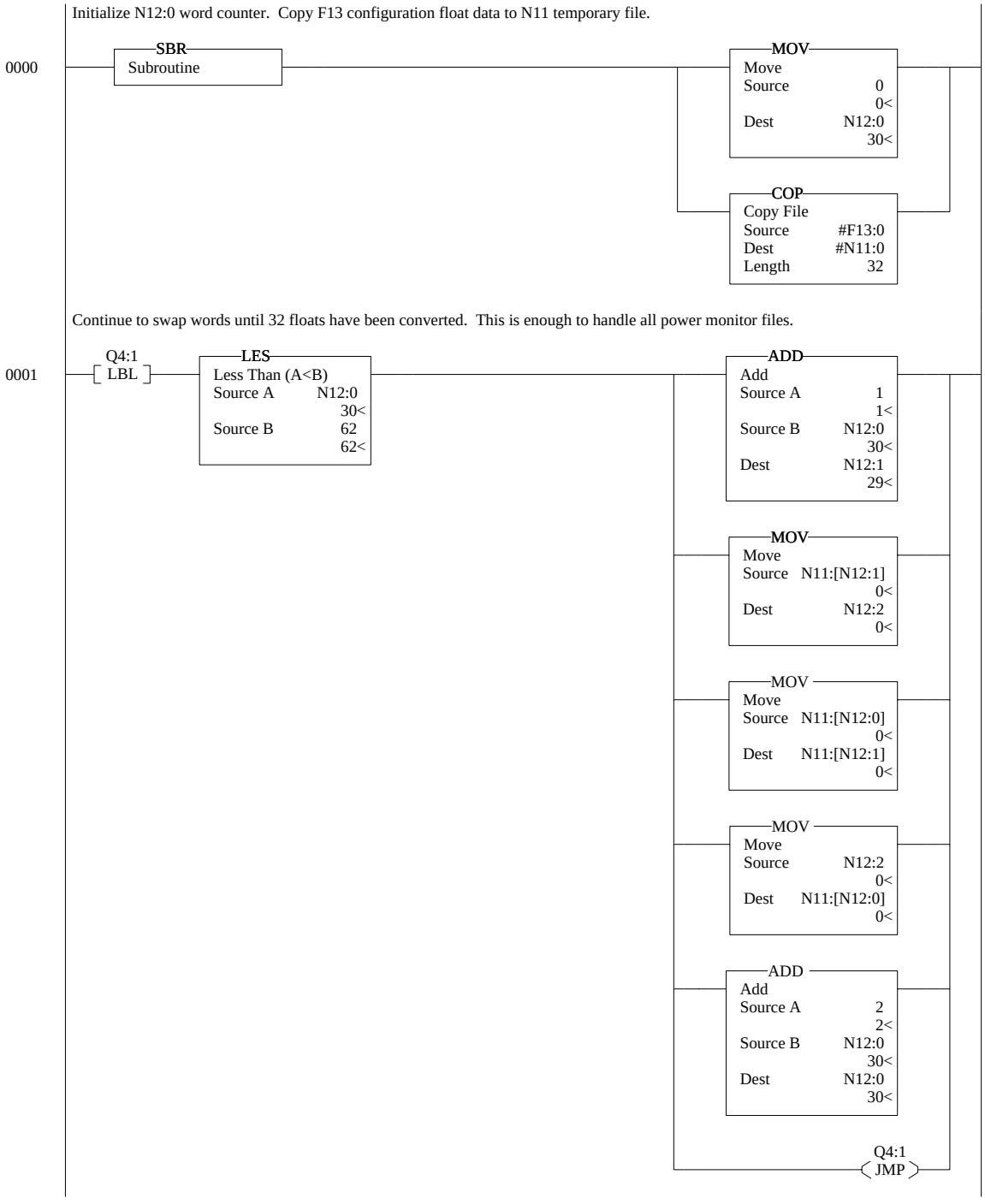
This rung looks for the done bit with no errors. When the done bit is received the return information is tranfered and mainten ance is performed. Integer information can be read from file N10:0. Float information can be read from F8:0. The enable and done bit s are turned off and the bit N7:9 is latched to notify the user that the transfer was successful. Bit B3:0/1 is set to transfer any floats t o the F8:0 file after swapping words from the incomming message.

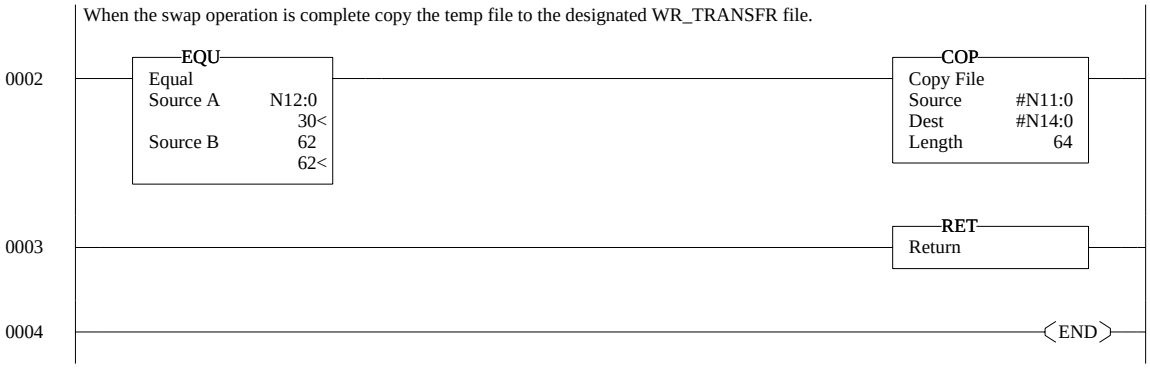



When an error or timeout occurs bit maintenance is performed to ready the ladder for the next message leaving the timeout or error bit set.
Time Out Bit
N7:0
8
Error bit
N7:0
12
Message Pending
B3:0
U
0
Perform Read
N9:11
U
1
Allow Write
N9:11
U
0
Enable Transfer Bit
N7:0
U
15
0005
This calls the word swap routine and returns after the swapping has been completed.
Swap Words
B3:0
1
Swap Words
B3:0
U
1
JSR
Jump To Subroutine
SBR File Number U:3
0006
END
0007


Perpare to swap words by copying source to N11 temp file. Initialize the word counter N12:0.
0000
SBR
Subroutine
COP
Copy File
Source #N10:0
Dest #N11:0
Length 64
MOV
Move
Source 0
0<
Dest N12:0
30<
Perform this task until all the words have been swapped. A size of 32 was selected to handle all power monitor files.
0001
Q3:1
LBL
LES
Less Than (A<B)
Source A N12:0
30<
Source B 30
30<
ADD
Add
Source A 1
1<
Source B N12:0
30<
Dest N12:1
29<
MOV
Move
Source N11:[N12:1]
0<
Dest N12:2
0<
MOV
Move
Source N11:[N12:0]
0<
Dest N11:[N12:1]
0<
MOV
Move
Source N12:2
0<
Dest N11:[N12:0]
0<
ADD
Add
Source A 2
2<
Source B N12:0
30<
Dest N12:0
30<
Q3:1
JMP


When the word swapping is complete transfer the results into F8 FLT_DATA file.
0002
EQU
Equal
Source A N12:0
30<
Source B 30
30<
COP
Copy File
Source #N11:0
Dest #F8:0
Length 32
0003
RET
Return
0004
END


Initialize N12:0 word counter. Copy F13 configuration float data to N11 temporary file.
0000
SBR
Subroutine
MOV
Move
Source 0
0<
Dest N12:0
30<
COP
Copy File
Source #F13:0
Dest #N11:0
Length 32
Continue to swap words until 32 floats have been converted. This is enough to handle all power monitor files.
0001
Q4:1
LBL
LES
Less Than (A<B)
Source A N12:0
30<
Source B 62
62<
ADD
Add
Source A 1
1<
Source B N12:0
30<
Dest N12:1
29<
MOV
Move
Source N11:[N12:1]
0<
Dest N12:2
0<
MOV
Move
Source N11:[N12:0]
0<
Dest N11:[N12:1]
0<
MOV
Move
Source N12:2
0<
Dest N11:[N12:0]
0<
ADD
Add
Source A 2
2<
Source B N12:0
30<
Dest N12:0
30<
Q4:1
JMP


When the swap operation is complete copy the temp file to the designated WR_TRANSFR file.
0002
EQU
Equal
Source A N12:0
30<
Source B 62
62<
COP
Copy File
Source #N11:0
Dest #N14:0
Length 64
0003
RET
Return
0004
END

Technical Specifications

Product Approvals

EtherNet/IP Conformance Testing

All Series B Powermonitor products equipped with an EtherNet/IP communications port bear the mark shown below. This mark indicates the Powermonitor 3000 has been tested at an Open Device Vendor Association (ODVA) independent test lab and has passed the EtherNet/IP conformance test. This test provides a level of assurance that the Powermonitor 3000 will interoperate with other conformance tested EtherNet/IP devices (including devices from other vendors). Two representative devices from the Powermonitor 3000 EtherNet/IP family of devices; the 1404-M405A-ENT B and the 1404-M8805A-ENT B have been tested by ODVA using EtherNet/IP Conformance Test version A2.8. The ODVA website (www.odva.org) maintains a list of products that have passed the conformance test at one of their test labs.

ControlNet Conformance Testing

All Powermonitor products equipped with a ControlNet communications port bear the mark shown below. This mark indicates the Powermonitor 3000 has been tested at a ControlNet International (CI) independent test lab and has passed the ControlNet conformance test. This test provides a level of assurance that the Powermonitor 3000 will interoperate with other conformance tested ControlNet devices (including devices from other vendors). Two representative device from the Powermonitor 3000 ControlNet family of devices; the 1404-M405A-CNT A and the 1404-M805A-CNT A have been tested by CI using ControlNet Conformance Test version 12. The CI website (www.ControlNet.org) maintains a list of products that have passed the conformance test at one of their test labs.

UL/CUL

UL 508 listed, File E96956, for Industrial Control Equipment and CUL Certified.

CE Certification

If this product bears the CE marking, it is approved for installation within the European Union and EEA regions. It has been designed to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole, documented in a technical construction file:

- EN 50081-2 - Generic Emission Standard, Part 2 - Industrial Environment
- EN 50082-2 - Generic Immunity Standard, Part 2 - Industrial Environment

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of IEC 1010-1.

This equipment is classified as open equipment and must be installed (mounted) in an enclosure during operation as a means of providing safety protection.

International Standard IEC 529 / NEMA / UL 508 Degree of Protection

The Bulletin 1404 Master Module is rated as IP10 degree of protection per International Standard IEC 529. It is considered an open device per NEMA and UL 508.

The Bulletin 1404 Display Module is rated as IP65 degree of protection per International Standard IEC 529. It is rated as Type 4 (Indoor) per NEMA and UL 508.

Follow the recommended installation guidelines to maintain these ratings.

ANSI/IEEE Tested

Meets or exceeds the Surge Withstand Capability (SWC) C37.90.1 - 1989 for protective relays and relay systems on all power connection circuit terminations.

Technical Specifications

Measurement Accuracy and Range

See table below for the rating of each parameter

Table D.1 Measurement Accuracy and Range

Parameter	Accuracy in % of Full Scale at +25°C 50/60 Hz Unity Power Facator				Nominal/Range
	M4	M5	M6	M8	
Voltage Sense Inputs: V1, V2, V3	±0.2%	±0.05%	±0.05%	±0.05%	347V/15 to 399V $_{L-N}$ RMS 600V/26 to 691V $_{L-L}$ RMS
Current Sense Input: I1, I2, I3, I4	±0.2%	±0.05%	±0.05%	±0.05%	5A/50 mA – 10.6A RMS
Frequency	±0.05 Hz	±0.05 Hz	±0.05 Hz	±0.05 Hz	50 or 60 Hz/40 to 75 Hz
Power Functions: kW, kVA, kVAR Demand Functions: kW, kVA Energy Functions: kWH, kVAH	ANSI C12.16 and EN 61036 Class 1 Accuracy	ANSI C12.20 and EN 60687 Class 0.5 Accuracy (Class 0.2 is also available)	ANSI C12.20 and EN 60687 Class 0.5 Accuracy (Class 0.2 is also available)	ANSI C12.20 and EN 60687 Class 0.5 Accuracy (Class 0.2 is also available)	
Metering Update Rates	55 to 80 ms	45 to 70 ms	45 to 75 ms	40to 90 ms	

General Input, Output, and Environmental Ratings

Table D.2 Input and Output Ratings

Control Power	1404-xxxxA-xxx	102V-264V ac 47-63 Hz or 106V-275V dc (0.2 Amp maximum loading)
	1404-xxxxB-xxx	18V to 50V dc (15 VA maximum loading)
Voltage Sense Inputs: V1, V2, V3	Input Impedance: 1M ohm minimum, 399V ac maximum; V1, V2 and V3 to N.	
Current Sense Inputs: I1, I2, I3, I4	Overload Withstand: 15 Amps Continuous, 200 Amps for one second Burden: 0.05 VA Impedance: 0.002 ohms Maximum Crest Factor at 5A is 3 Starting Current: 5 mA	
Status Inputs	Contact Closure (Internal 24Vdc)	
Control Relay KYZ Output	(1) ANSI C37.90-1989 trip duty (1) Solid State KYZ - 80mA at 240Vdc-300Vdc	

Table D.3 Control Relay(1)

Rating	50/60 Hz AC rms	DC
Maximum Resistive Load Switching	10A at 250V (2500VA)	10A at 30V and 0.25A at 250V
Minimum Load Switching	10mA at 24V	10mA at 24V
UL 508, CSA 22.2, IEC Rating Class	B300	Q300
Maximum Make Values (Inductive Load)	30A at 120V 15A at 240V (3600VA)	0.55A at 125V 0.27A at 250V (69VA)
Maximum Break Values (Inductive Load)	3A at 120V 1.5A at 240V (360VA)	0.55A at 125V 0.27A at 250V (69VA)
Maximum Motor Load Switching	1/3 HP at 125V 1/2 HP at 250V	

(1) Meets ANSI/IEEE C37.90-1989 standards for trip duty.

Table D.4 Relay Life(1)

Parameter	Number of Operations
Mechanical	5×10^6
Electrical	1×10^5

(1) Meets ANSI/IEEE C37.90-1989 standards for trip duty.

Table D.5 General Specifications

Dielectric Withstand	Control Power	2000 Volts
	Voltage Inputs	2000 Volts
	Current Inputs	2000 Volts
	Status Inputs	500 Volts
	Control Relays	1600 Volts
Terminal Blocks	Power Supply and Voltage input Terminals	12 AWG (4 mm2) max., 9 lb-in (1.02 Nm) Torque., 75°C or Higher Copper Wire only
	Relay, KYZ outputs, Current input terminals[1]	14 AWG (2.5 mm2) max., 10.4 lb-in (1.18 Nm) Torque., 75°C or Higher Copper Wire only
	Status inputs, RS485	14 AWG (2.5 mm2) max., 5 lb-in (0.56 Nm) Torque
	RIO, DNT (When present)	14 AWG (2.5 mm2) max., 5 lb-in (0.56 Nm) Torque
Operating Temperature	-20°C to +60°C (-40°F to +140°F) Cat. No. 1404-DM, 1404-Mxxxx-000, 1404-Mxxxx-DNT +0°C to +55°C (+32°F to +131°F) 1404-Mxxxx-232, -RIO, -ENT, -CNT	
Storage Temperature	-40°C to +85°C (-40°F to +185°F)	
Humidity	5% to 95%, Noncondensing	
Vibration	10 to 500 Hz: 2G Operational (±0.012 in.)	
Shock	1/2 Sine Pulse, 11 ms duration: 30G Operational and 30G Nonoperational	

(1) Recommended Ring lug: AMP part # 320634

Frequently Asked Questions

Q. Can I program the power monitor through the display?

A. Yes. All programmable attributes can be accessed and programmed through the display module.

Q. Do I need a display module?

A. All features of the monitor can be accessed and programmed through the communication port(s). The display module is a highly recommended option.

Q. Can I power the power monitor from the source being monitored?

A. Yes, but it's not advisable. Assuming a voltage match, logging of power outages and voltage phase loss anomalies would be difficult, if not impossible.

Q. What determines what information I get using RIO block transfers?

A. The word length of the block transfer.

Q. My Volt and Amp readings look good, but why are my power numbers way off?

A. One or more Current/Voltage transformers are wired with reverse polarity or improper phase sequence.

Q. What size fuses do I use for my voltage inputs?

A. Size the fuses to the National Electric Code for the size of the wire being used.

Q. Why do I need shorting terminal blocks for the current transformers?

A. If for any reason, the meter's current transformer wires are removed or disturbed to cause an open circuit in the Current Transformers secondary while primary current is applied, a hazardous voltage will occur, which may cause personal injury, death, property damage, or economic loss.

Q. Can I monitor several loads from one monitor?

A. It is not advisable to switch current transformer inputs. Besides the need for special current transformer switches, confusion over logged data and setpoint activation would also have to be considered.

Q. Can I change communications networks?

A. Unlike the other Allen-Bradley power monitors, the Powermonitor 3000 ships with a non-interchangeable communications network card.

Powermonitor 3000 EtherNet/IP Device Profile

This section defines the specific CIP Objects, Instances, Attributes and Services supported by the

Powermonitor 3000 system. This information is of particular importance to anyone wishing to integrate the Powermonitor 3000 system into existing or planned shop floor networks.

General

For the purposes of this device profile, it is the combination of both a PM 3000 and an EtherNet/IP DC together which comprise a complete Powermonitor 3000 system. That system is capable of providing the user with access to a wide variety of power metering data via an EtherNet I/P network. The data can be accessed either as instances of the device's Assembly Object or in the familiar PCCC *FILE:ELEMENT* notation.

TIP This profile only documents objects with are either proprietary or in some way altered from their generic behavior. Standard CIP objects which are completely generic in their interface are documented in the EtherNET/IP Specification.

Object Model and Interface

The Powermonitor 3000 system is represented on the EtherNet/IP network by the following Object Model:

Table F.1

Object Class	Instance Numbers	Number of Connections
Identity	1,2	0
Assembly	1-51, 99	64
PCCC	1	0
NVS	2	0

The objects within the Powermonitor 3000 system have the following interfaces:

Table F.2

Object	Interface
Identity	Message Router
Assembly	Connection or Message Router
PCCC	Message Router
NVS	Message Router

Identity Object

Table F.3

Class Code: 01
hex

The Identity Object is used to provide identification information about the device. The Powermonitor 3000 system supports two instances of the identity object to provide identity information about the PM 3000 itself as well as the DC.

Section 5-2 of the *CIP Common Specification* provides additional details about this object.

Class Attributes

Table F.4

Attr ID	Access	Name	Data Type	Default Value
0x01	Get	Revision	UINT	1
0x02	Get	Max Instance	UINT	2
0x06	Get	Max Class Attribute	UINT	7
0x07	Get	Max Instance Attribute	UINT	7

Instance Attributes

Table F.5

Attr ID	Access	Name	Data Type
0x01	Get	Vendor ID	UINT
0x02	Get	Device Type	UINT
0x03	Get	Product Code	UINT
0x04	Get	Revision	Struct of:
		Major Revision	USINT
		Minor Revision	USINT
0x05	Get	Status	WORD
0x06	Get	Serial Number	UDINT
0x07	Get	Product Name	SHORT_STRING

Common Services

Table F.6

Service Code	Class/Instance Usage	Service Name
0x01	Class/Instance	Get_Attributes_All
0x05	Instance	Reset
0x0E	Instance	Get_Attribute_Single

Get Attribute All Service

The Get Attribute All service returns a concatenation of all class or instance attributes.

Reset Service

The reset service accepts the following request parameter:

Table F.7 Request Parameters

Parameter	Data Type	Description
Type	USINT	Type of Reset to perform

Behavior

The Powermonitor 3000 system's Identity instances handle reset services in the following manner regardless of the reset type requested:

Instance 1 (PM 3000) – Respond successfully to the request, but continue normal operation.

Instance 2 (DC) – Respond successfully to the request and notify the PM 3000 to reset the DC.

Get Attribute Single Service

The Get Attribute Single service returns the single attribute specified by the parameter *Attribute ID*.

Table F.8 Request Parameters

Parameter	Data Type	Description
Attribute ID	UINT	Identifies the attribute to be read / returned

Identity Object Instances

The DC's Identity Object supports the following instances:

Instance 1 (PM 3000)

Instance 1 represents the PM 3000 device. Since instance 1 of the Identity Object is the one which is browsed by RSLinx, the complete device (i.e. the PM 3000 with DC) will appear in RS Who as a PM 3000 rather than a DC.

Instance 1 of the Identity Object reports the following instance specific attribute values:

Table F.9 Instance 1 Attribute Values

Attr ID	Name	Value
0x01	Vendor ID	1 (Rockwell Automation)
0x02	Device Type	0x73 (115)
0x03	Product Code	0x39 (57)
0x04	Revision	1.0
0x05	Status	TBD
0x06	Serial Number	PM 3000 Serial Number
0x07	Product Name	Powermonitor 3000

Instance 2 (EtherNet/IP DC)

Instance 2 represents the EtherNET/IP DC itself. It reports the following instance specific attribute values:

Table F.10 Instance 2 Attribute Values

Attr ID	Name	Value
0x01	Vendor ID	1 (Rockwell Automation)
0x02	Device Type	0x0C (Comm Adapter)
0x03	Product Code	TBD
0x04	Revision	1.0
0x05	Status	EtherNet/IP Status
0x06	Serial Number	DC Serial Number
0x07	Product Name	PM 3000 EtherNet/IP DC

Assembly Object

Table F.11

Class Code: 04
hex

The Powermonitor 3000 system's Assembly instances act as repositories for the full variety of data which the system supports.

Section 5-5 of the *CIP Common Specification* provides additional details regarding this object.

Class Attributes

Table F.12

Attr	Access	Name	Data Type	Default Value
0x01	Get	Object Revision	UINT	2
0x02	Get	Max Instance	UINT	53

Instance Attributes

Table F.13

Attr	Access	Name	Data Type	Default Value
0x03	Get / Set	Data	Instance Dependant (See section 4.1.6.1)	All of the member data packed into one array.
0x04	Get	Size	Size (in bytes) of the Data attribute	Instance Dependant (See section 4.1.6.1)

Common Services

Table F.14

Service Code	Class/Instance Usage	Service Name
0x0E	Class/Instance	Get Attribute Single
0x10	Instance	Set Attribute Single

Get Attribute Single Service

The Get Attribute Single service returns the single attribute specified by the parameter *Attribute ID*.

Table F.15 Request Parameters

Parameter	Data Type	Description
Attribute ID	UINT	Identifies the attribute to be read / returned

Set Attribute Single Service

The Set Attribute Single service sets the single attribute specified by the parameter *Attribute ID* to the value specified by the parameter *Attribute Data*.

Table F.16 Request Parameters

Parameter	Data Type	Description
Attribute ID	UINT	Identifies the attribute to be read / returned
Attribute Data	Attribute Specific	Contains the value to which the specified attribute is to be set

Assembly Object Instances

The DC's Assembly Object supports 63 instances. The Data attributes of instances 1 and 2 are accessed via Class 1 scheduled connections, while the Data attribute of instances 3 to 73 are accessed via Class 3 or UCMM unscheduled connections.

The table shown in *Appendix A* of this document defines the size and content of the Data attribute for each of those instances.

Connections

The Assembly Object will support both scheduled (Class 1) and unscheduled (Class 3 & UCMM) connections. A maximum of 64 Class 1 connections are supported to instance 1 of the Assembly Object, but only 1 is supported to instance 2 of the Assembly Object. Unscheduled connections (Class 3 & UCMM) can also be used to access instances 1 – 51 of the Assembly Object.

Behavior

The purpose of the Assembly Object is to act as a network interface to the PM 3000's data. That data is accessed by a variety of means.

Instances 1 and 2 of the Assembly Object support Class 1 connections in order to provide network scanners with access to the PM 3000's I/O data. Such messaging is said to be *I/O Messaging*. The remainder of

the Assembly Object instances may be accessed via *Unscheduled Messaging*; either UCMM messages or Class 3 connections.

For reasons dictated by existing PM 3000 firmware functionality, the manner in which the Assembly Object accesses PM 3000 data differs for writes as opposed to reads. Both I/O and unscheduled writes of data to the PM 3000 are handled via interaction with the DPRAM task while reads are resolved directly from mirrored data within the DC's RAM.

PCCC Object

Table F.17

Class Code: 0x67 hex

The PCCC Object is a Rockwell Automation vendor specific object which provides a means to handle PCCC messages encapsulated inside CIP messages.

Class Attributes

The PCCC Object does not support any class attributes.

Instance Attributes

The PCCC Object does not support any instance attributes.

Common Services

The PCCC Object does not support any common services.

Class-Specific Service

Table F.18

Service Code	Class/Instance Usage	Service Name
0x4B	Instance	Execute PCCC

Execute PCCC Service

The Execute PCCC service is sent by a remote application to perform a PCCC request. The service accepts the following request parameters, which represent a completely encapsulated PCCC command:

Table F.19 Request Parameters

Name	Data Type	Parameter Description	Semantics of Values
Length	USINT	Length of Requestor ID	Number of bytes, including Length, Vendor, Serial Number and other fields.
Vendor	UINT	Vendor Number of requester	Same as the attribute in the Device Object of the same name.
Serial Number	UDINT	ASA serial number of requestor	Same as the attribute in the Device Object of the same name.
Other	Product Specific	Identifier of user, task, etc. on the requester	Product specific
CMD	USINT	Command Byte	Refer to PCCC specification
STS	USINT	0	Must be 0 on PCCC requests
TNSW	UINT	Transport Word	None. Same value must be returned to requestor.
FNC	USINT	Function Code (Not used for all Command Bytes)	Refer to PCCC specification
PCCC parameters	Array of USINT	CMD/FNC specific parameters	Refer to PCCC specification

TIP

The *Length* parameter contains the total length of the *Vendor*, *Serial Number* and *Other* parameters to follow. None of these values are actually used by the PCCC Object, but are instead simply preserved intact in the associated response.

The DC will respond to the Execute PCCC service with the following response parameters, which represent a completely encapsulated PCCC response:

Table F.20 Response Parameters

Name	Data Type	Parameter Description	Semantics of Values
Length	USINT	Length of Requestor ID	Same value as in request.
Vendor	UINT	Vendor Number of requester	Same value as in request.
Serial Number	UDINT	ASA serial number of requestor	Same value as in request.
Other	Product Specific	Identifier of user, task, etc. on the requester	Same value as in request.
CMD	USINT	Command Byte	Refer to PCCC specification
STS	USINT	Status Byte	Refer to PCCC specification
TNSW	UINT	Transport Word	None. Same value as the request
EXT_STS	USINT	Extended Status: not used for all CMD's	Refer to PCCC specification
PCCC results	Array of USINT	CMD/FNC specific result data	Refer to PCCC specification

TIP

The *Length* parameter contains the total length of the *Vendor*, *Serial Number* and *Other* parameters to follow. None of these values are actually used by the PCCC Object, but are instead simply preserved intact in the associated response.

Supported PCCC Commands

The PCCC object supports the following PCCC commands:

- PLC-5 Typed Write
- PLC-5 Typed Read
- Protected Typed Logical Read, 2 address fields
- Protected Typed Logical Write, 2 address fields
- Word Range Read
- Word Range Write

These commands are supported on the Logix 5, SLC 500 and ControlLogix processors and are used by network devices to send data to, or receive data from the PM 3000. Both commands provide implicit data type information within their address fields which is used by the DC to validate the read before the data items are sent.

The last four items in the list above are supported only in Series B Powermonitor 3000 units with communications firmware 1.22 or later.

Section 5.3.5.81 of *Programmable Controller Communication Commands* provides the full details regarding these commands.

NVS Object

Table F.21

Class Code: A1 hex

The Non-Volatile Storage (NVS) Object provides access to the DC's non-volatile flash memory. It provides a mechanism for writing to the defined instances of that object. Because the NVS Object is a vendor specific object, it is not defined in the *CIP Common Specification*.

Class Attributes

Table F.22

Attr ID	Access	Name	Data Type	Default Value
1	Get	Revision	UINT	1
2	Get	Max Instance	UINT	2

Instance Attributes

Table F.23

Attr ID	Access	Name	Data Type	Default Value
1	Get	Status	UINT	
2	Get	Revision	UINT	1

Semantics

The NVS Object's attributes are defined as follows:

Revision - The current major and minor revision of the NVS Object itself.

Status - The status attribute reports the current status of the NVS Object instance. The Status can be any one of the following:

Table F.24

Value	Description
0	Nothing new / No Update
1	Success on Transfer
2	Success on Programming
3	Failure on Transfer
4	Failure on Programming
5	Faulted

Instance Revision - The current major and minor revision of firmware or data represented by this instance of the NVS Object.

TIP The DC's web content flash file does not utilize revision levels. Consequently, instance 2 of the NVS Object always reports a major / minor revision of 1.0.

Common Services

Table F.25

Service Code	Class/Instance Usage	Service Name
0x01	Class/Instance	Get_Attribute_All

Get Attribute All Service

The Get Attribute All service returns a concatenation of all class or instance attributes.

Class Specific Services

Table F.26

Service Code	Class/Instance Usage	Service Name
0x4B	Instance	Update
0x4D	Instance	Transfer

Update Service

The Update service is sent by a remote application to signal the beginning of an update session. The service accepts the following request parameters:

Table F.27 Request Parameters

Parameter	Data Type	Description
Size	UDINT	Number of bytes in this update
Base Address	UDINT	Starting address for the storage of this update

The DC will respond to the Update service with the following response parameters:

Table F.28 Response Parameters

Parameter	Data Type	Description
Boot Update Flag	UINT	Indicates if the Boot Code is to be updated.
Incremental Burn	UINT	Number of chunks transferred prior to being programmed.
Transfer Size	UINT	Chunk size for the transfers. (128 bytes)
Instance Revision	UINT	Major and minor revision of the firmware or data represented by this instance
Upload Size	UDINT	Size of the upload in bytes.

Transfer Service Parameters

The Transfer service is sent repeatedly by a remote application to transfer the actual update data to the DC a chunk at a time. The service accepts the following parameters:

Table F.29 Request Parameters

Parameter	Data Type	Description
Chunk Number	UDINT	Number of chunks transferred (0 based)
Data	Array of Bytes	Data representing the new firmware

The DC responds to the Transfer service with the following parameters:

Table F.30 Response Parameters

Parameter	Data Type	Description
Chunk Number	UDINT	Same as request
Status	UINT	Status instance attribute

NVS Object Instances

The DC's NVS Object will support the following instances:

Instance 1 (EtherNet/IP DC Firmware)

Instance 1 represents the EtherNet/IP DC firmware. This instance provides the mechanism for its update.

Additional Powermonitor 3000 Ethernet Features

The Powermonitor 3000 system also supports a variety of other Ethernet features.

SNTP Client

The DC implements a Simple Network Time Protocol client in order to provide a means for the Powermonitor 3000 system to receive periodic updates to its system clock.

TIP In order for the SNTP client to operate, there must be access to an SNTP server.

Configuration Parameters

Before the SNTP Client can be initialized or run, it requires the following three configuration parameters which are provided by the host PM 3000 during initialization:

Table F.31 SNTP Client Configuration Parameters

Name	Data Type
SNTP Server Address	UDINT
Interval	UINT
Time Zone Adjustment	INT

TIP These configuration parameters are only passed to the DC by the PM 3000 during initialization. Consequently, changes to these parameters within the PM 3000 will not take effect within the DC until the next time it is reset.

If any of the SNTP Client Configuration Parameters received by the DC during initialization are invalid, the SNTP Client task will not be started and the SNTP Client services will be disabled.

SNTP Server Address

A 32 bit little endian value representing the SNTP server's dotted IP address. Each byte represents one segment of the SNTP server's IP address as in the following example:

String IP Address: "65.106.34.209" = DWORD format: 0x D1 22 6A 41

Providing an IP address of 0x 00 00 00 00 will disable the SNTP Client.

Interval

The interval, in seconds, at which the SNTP Client polls the SNTP Server for time data. The following limits apply:

0 < Interval < 65,535

An Interval of 0 seconds disables the SNTP client

Time Zone Adjustment

The positive or negative number of hours by which the local time zone differs from GMT. The DC *subtracts* this value from the hour returned by the SNTP server before updating the PM 3000's system clock. Areas west of the prime meridian to the international date line will have a positive Time Zone Adjustment, while areas east of the prime meridian to the international date line will have a negative Time Zone Adjustment.

The following limits apply:

-12 <= Time Zone Adjustment <= 12

Time Zone Adjustments outside the above limits will disable the SNTP Client.

End of Interval Pulse Producer / Consumer

The DC supports both the production and consumption of End Of Interval Pulses over an Ethernet network by the PM 3000.

End of Interval Pulse signals are discrete signals provided by the electric utility's meter to mark the end of each demand billing period. These signals can be detected by a PM 3000 discrete input connected

to the utility meter and propagated to other PM 3000s on the same network.

Configuration Parameters

Before the DC can either produce or consume EOIP signals, it requires the following configuration parameter:

Table F.32 End of Interval Pulse Task Configuration Parameters

Name	Data Type
Port	UINT

Port

The UDP port number on which the EOIP signal packet will be transmitted or received.

TIP A port value of 0 disables both the EOIP producer and consumer functionality.

Dynamic Web Server Functionality

The DC implements a dynamic web server so that run time data from the PM 3000, as well as other web content desired, can be viewed by any standard web browser on the network.

Configuring the Web Server

The DC's dynamic web server does not require any specific configuration parameters from the PM 3000 during initialization.

Powermonitor 3000 ControlNet Device Profile

This section defines the specific CIP Objects, Instances, Attributes and Services supported by the Powermonitor 3000 system. This information is of particular importance to anyone wishing to integrate the Powermonitor 3000 system into existing or planned shop floor networks.

General

For the purposes of this device profile, it is the combination of both a Powermonitor 3000 and a ControlNet Daughter Card together which comprise a complete Powermonitor 3000 system. That system is capable of providing the user with access to a wide variety of power metering data via a ControlNet network. The data can be accessed either as instances of the device's Assembly Object or in the familiar PCCC *FILE:ELEMENT* notation.

Object Model and Interface

The Powermonitor 3000 system is represented on the ControlNet network by the following Object Model:

Table G.1 Object Model

Object Class	Instance Numbers	Number of Connections
Identity	1,2	0
Assembly	1-51, 99	64
PCCC	1	0
NVS	2	0

The objects within the Powermonitor 3000 system shall have the following interfaces:

Table G.2 Interface

Object	Interface
Identity	Message Router

Table G.2 Interface

Object	Interface
Assembly	Connection or Message Router
PCCC	Message Router
NVS	Message Router

Identity Object

Class Code: 01
hex

The Identity Object is used to provide identification information about the device. The Powermonitor 3000 system supports two instances of the identity object to provide identity information about the PM 3000 itself as well as the DC.

Section 5-2 of the *CIP Common Specification* provides additional details about this object.

Class Attributes

Table G.3 Class Attributes

Attr ID	Access	Name	Data Type	Default Value
0x01	Get	Revision	UINT	1
0x02	Get	Max Instance	UINT	2
0x06	Get	Max Class Attribute	UINT	7
0x07	Get	Max Instance Attribute	UINT	7

Instance Attributes

Table G.4 Instance Attributes

Attr ID	Access	Name	Data Type
0x01	Get	Vendor ID	UINT
0x02	Get	Device Type	UINT
0x03	Get	Product Code	UINT
0x04	Get	Revision	Struct of:

Table G.4 Instance Attributes

Attr ID	Access	Name	Data Type
		Major Revision	USINT
		Minor Revision	USINT
0x05	Get	Status	WORD
0x06	Get	Serial Number	UDINT
0x07	Get	Product Name	SHORT_STRING

Common Services

Table G.5 Common Services

Service Code	Class/Instance Usage	Service Name
0x01	Class/Instance	Get_Attributes_All
0x05	Instance	Reset
0x0E	Instance	Get_Attribute_Single

Get Attribute All Service

The Get Attribute All service returns a concatenation of all class or instance attributes.

Reset Service

The reset service accepts the following request parameter:

1. Request Parameters

Table G.6 Reset Service

Parameter	Data Type	Description
Type	USINT	Type of Reset to perform

Behavior

The Powermonitor 3000 system's Identity instances handle reset services in the following manner according to the reset type requested:

Table G.7 Reset Behavior

Instance	Reset Type	Action
1 (PM 3000)	0 (Out of Box)	Notify the PM 3000 and respond to the request
1 (PM 3000)	1 (Power Cycle)	Return 0x09 (Bad Attribute Data)
2 (DC)	0 (Out of Box)	Notify the PM 3000 and respond to the request
2 (DC)	1 (Power Cycle)	Return 0x09 (Bad Attribute Data)

Get Attribute Single Service

The Get Attribute Single service returns the single attribute specified by the parameter *Attribute ID*.

Request Parameters

Table G.8 Get Attribute Single Service

Parameter	Data Type	Description
Attribute ID	UINT	Identifies the attribute to be read / returned

Identity Object Instances

The DC's Identity Object supports the following instances:

Instance 1 (PM 3000)

Instance 1 represents the PM 3000 device. Since instance 1 of the Identity Object is the one which is browsed by RS Linx, the complete device (i.e. the PM 3000 with DC) will appear in RS Who as a PM 3000 rather than a DC.

Instance 1 of the Identity Object reports the following instance specific attribute values:

Table G.9 Instance 1 Attribute Values

Attr ID	Name	Value
0x01	Vendor ID	1 (Rockwell Automation)
0x02	Device Type	0x73 (115)
0x03	Product Code	0x39 (57)
0x04	Revision	1.0
0x05	Status	TBD
0x06	Serial Number	PM 3000 Serial Number
0x07	Product Name	Powermonitor 3000

Instance 2 (ControlNet DC)

Instance 2 represents the ControlNet DC itself. It reports the following instance specific attribute values:

Table G.10 Instance 2 Attribute Values

Attr ID	Name	Value
0x01	Vendor ID	1 (Rockwell Automation)
0x02	Device Type	0x0C (Comm Adapter)
0x03	Product Code	TBD
0x04	Revision	1.0
0x05	Status	ControlNet Status
0x06	Serial Number	DC Serial Number
0x07	Product Name	PM 3000 ControlNet DC

Assembly Object

Class Code: 04
hex

The Powermonitor 3000 system's Assembly instances act as repositories for the full variety of data which the system supports.

Section 5-5 of the *CIP Common Specification* provides additional details regarding this object.

Class Attributes

Table G.11 Assembly Object Class Attributes

Attr	Access	Name	Data Type	Default Value
0x01	Get	Object Revision	UINT	2
0x02	Get	Max Instance	UINT	63

Instance Attributes

Table G.12 Assembly Object Instance Attributes

Attr	Access	Name	Data Type	Default Value
0x03	Get / Set	Data	Instance Dependant (See section 4.1.6.1)	All of the member data packed into one array.
0x04	Get	Size	Size (in bytes) of the Data attribute	Instance Dependant (See section 4.1.6.1)

Common Services

Table G.13 Assembly Object Common Services

Service Code	Class/Instance Usage	Service Name
0x0E	Class/Instance	Get Attribute Single
0x10	Instance	Set Attribute Single

Get Attribute Single Service

The Get Attribute Single service will return the single attribute specified by the parameter *Attribute ID*.

Table G.14 Request Parameters

Parameter	Data Type	Description
Attribute ID	UINT	Identifies the attribute to be read / returned

Set Attribute Single Service

The Set Attribute Single service will set the single attribute specified by the parameter *Attribute ID* to the value specified by the parameter *Attribute Data*.

Table G.15 Request Parameters

Parameter	Data Type	Description
Attribute ID	UINT	Identifies the attribute to be read / returned
Attribute Data	Attribute Specific	Contains the value to which the specified attribute is to be set

Assembly Object Instances

The DC's Assembly Object will support 63 instances. The Data attribute of instances 1 and 2 can be accessed via Class 1 scheduled connections, while the Data attribute of instances 3 to 73 can be accessed via Class 3 or UCMM unscheduled connections.

The table shown in *Appendix A* of this document defines the size and content of the Data attribute for each of those instances.

Connections

The Assembly Object will support both scheduled (Class 1) and unscheduled (Class 3 & UCMM) connections. A maximum of 64 Class 1 connections will be supported to instance 1 of the Assembly Object, but only 1 will be supported to instance 2 of the Assembly Object. Unscheduled connections (Class 3 & UCMM) can also be used to access instances 1 to 51 of the Assembly Object.

Behavior

The purpose of the Assembly Object is to act as a network interface to the PM 3000's data. That data can be accessed by a variety of means.

Instances 1 and 2 of the Assembly Object support Class 1 connections in order to provide network scanners with access to the PM 3000's I/O data. Such messaging is said to be *I/O Messaging*. The remainder of the Assembly Object instances may be accessed via *Unscheduled Messaging*; either UCMM messages or Class 3 connections.

For reasons dictated by existing PM 3000 firmware functionality, the way in which the Assembly Object accesses PM 3000 data differs for writes as opposed to reads. Both I/O and unscheduled writes of data to the PM 3000 are handled via interaction with the DPRAM task, while reads are resolved directly from mirrored data within the DC's RAM.

Assembly Instance Data Map

See Table A.1 on page A-2 for information on the Assembly Instance Data Map.

PCCC Object

Class Code: 0x67 hex

The PCCC Object is a Rockwell Automation vendor specific object which provides a way to handle PCCC messages encapsulated inside CIP messages.

Class Attributes

The PCCC Object does not support any class attributes.

Instance Attributes

The PCCC Object does not support any instance attributes.

Common Services

The PCCC Object does not support any common services.

Class-Specific Service

Table G.16 PCCC Object Class-Specific Service

Service Code	Class/Instance Usage	Service Name
0x4B	Instance	Execute PCCC

Execute PCCC Service

The Execute PCCC service is sent by a remote application to perform a PCCC request. The service accepts the following request parameters, which represent a completely encapsulated PCCC command:

Table G.17 PCCC Object Request Parameters

Name	Data Type	Parameter Description	Semantics of Values
Length	USINT	Length of Requestor ID	Number of bytes, including Length, Vendor, Serial Number and other fields.
Vendor	UINT	Vendor Number of requester	Same as the attribute in the Device Object of the same name.
Serial Number	UDINT	ASA serial number of requestor	Same as the attribute in the Device Object of the same name.
Other	Product Specific	Identifier of user, task, etc. on the requester	Product specific
CMD	USINT	Command Byte	Refer to PCCC specification
STS	USINT	0	Must be 0 on PCCC requests

Table G.17 PCCC Object Request Parameters

Name	Data Type	Parameter Description	Semantics of Values
TNSW	UINT	Transport Word	None. Same value must be returned to requestor.
FNC	USINT	Function Code (Not used for all Command Bytes)	Refer to PCCC specification
PCCC parameters	Array of USINT	CMD/FNC specific parameters	Refer to PCCC specification

TIP

The Length parameter contains the total length of the Vendor, Serial Number and Other parameters to follow. None of these values are actually used by the PCCC Object, but are instead simply preserved intact in the associated response.

The DC will respond to the Execute PCCC service with the following response parameters, which represent a completely encapsulated PCCC response:

Table G.18 Response Parameters

Name	Data Type	Parameter Description	Semantics of Values
Length	USINT	Length of Requestor ID	Same value as in request.
Vendor	UINT	Vendor Number of requester	Same value as in request.
Serial Number	UDINT	ASA serial number of requestor	Same value as in request.
Other	Product Specific	Identifier of user, task, etc. on the requester	Same value as in request.
CMD	USINT	Command Byte	Refer to PCCC specification
STS	USINT	Status Byte	Refer to PCCC specification
TNSW	UINT	Transport Word	None. Same value as the request
EXT_STS	USINT	Extended Status: not used for all CMD's	Refer to PCCC specification
PCCC results	Array of USINT	CMD/FNC specific result data	Refer to PCCC specification

TIP The Length parameter contains the total length of the Vendor, Serial Number and Other parameters to follow. None of these values are actually used by the PCCC Object, but are instead simply preserved intact in the associated response.

Supported PCCC Commands

The PCCC object supports only the following PCCC commands:

Typed Write

Typed Read

These commands are supported on the Logix 5, SLC 500 and ControlLogix processors and are used by network devices to send data to, or receive data from the PM 3000. Both commands provide implicit data type information within their address fields which are used by the DC to validate the read before the data items are sent.

Section 5.3.5.81 of *Programmable Controller Communication Commands* provides the full details regarding these commands.

Operation

Since the Powermonitor 3000 does not implement the requisite PLC style file system implied by the *Typed Write* and *Typed Read* commands, the *System Address* parameter specified within the command will instead be used to map the request to specific data items within the PM 3000 according to the table shown in *Appendix A* of this document.

PCCC Object Data Map

See Table A.1 on page A-2 for information on the PCCC Object Data Map.

NVS Object

Class Code: A1 hex

The Non-Volatile Storage (NVS) Object provides access to the DC's non-volatile flash memory. It provides a mechanism for writing to the defined instances of that object. Because the NVS Object is a vendor specific object, it is not defined in the *CIP Common Specification*.

Class Attributes

Table G.19 NNVS Ojbect Class Attributes

Attr ID	Access	Name	Data Type	Default Value
1	Get	Revision	UINT	1
2	Get	Max Instance	UINT	2

Instance Attributes

Table G.20 NNVS Ojbect Instance Attributes

Attr ID	Access	Name	Data Type	Default Value
1	Get	Status	UINT	
2	Get	Revision	UINT	1

Semantics

The NVS Object's attributes are defined as follows:

Revision - The current major and minor revision of the NVS Object itself.

Status - The status attribute reports the current status of the NVS Object instance. The Status can be any one of the following:

Table G.21 NNVS Ojbect Semantics

Value	Description
0	Nothing new / No Update
1	Success on Transfer
2	Success on Programming
3	Failure on Transfer
4	Failure on Programming
5	Faulted

Instance Revision - The current major and minor revision of firmware or data represented by this instance of the NVS Object.

TIP The daughter card's web content flash file does not utilize revision levels. Consequently, instance 2 of the NVS Object will always report a major / minor revision of 1.0.

Common Services

Table G.22 NNVS Ojbect Common Services

Service Code	Class/Instance Usage	Service Name
0x01	Class/Instance	Get_Attribute_All

Get Attribute All Service

The Get Attribute All service will return a concatenation of all class or instance attributes.

Class Specific Services

Table G.23 NNVS Ojbect Class Specific Services

Service Code	Class/Instance Usage	Service Name
0x4B	Instance	Update
0x4D	Instance	Transfer

Update Service

The Update service is sent by a remote application to signal the beginning of an update session. The service accepts the following request parameters:

Table G.24 Request Parameters

Parameter	Data Type	Description
Size	UDINT	Number of bytes in this update
Base Address	UDINT	Starting address for the storage of this update

The DC will respond to the Update service with the following response parameters:

Table G.25 Response Parameters

Parameter	Data Type	Description
Boot Update Flag	UINT	Indicates if the Boot Code is to be updated.
Incremental Burn	UINT	Number of chunks transferred prior to being programmed.
Transfer Size	UINT	Chunk size for the transfers. (128 bytes)
Instance Revision	UINT	Major and minor revision of the firmware or data represented by this instance
Upload Size	UDINT	Size of the upload in bytes.

Transfer Service Parameters

The Transfer service is sent repeatedly by a remote application to transfer the actual update data to the DC a chunk at a time. The service accepts the following parameters:

Table G.26 Request Parameters

Parameter	Data Type	Description
Chunk Number	UDINT	Number of chunks transferred (0 based)
Data	Array of Bytes	Data representing the new firmware

The DC will respond to the Transfer service with the following parameters:

Table G.27 Response Parameters

Parameter	Data Type	Description
Chunk Number	UDINT	Same as request
Status	UINT	Status instance attribute

NVS Object Instances

The DC's NVS Object will support the following instances:

Instance 1 (Powermonitor 3000 DC Firmware)

Instance 1 represents the Powermonitor 3000 firmware. While the PM 3000 does not currently support firmware upgrades via ControlFlash, this instance has been reserved for that possibility in the future.

Instance 2 (ControlNet DC Firmware)

Instance 2 represents the ControlNet DC firmware. This instance provides the mechanism for its update.

Glossary Term

ampere

A unit of electrical current or rate of flow of electrons. One volt across ‘one ohm of resistance causes a current flow of one ampere. A flow of one coulomb per second equals one amp.

apparent power

The product of voltage magnitude and current magnitude in a circuit. Units are VA or some multiple thereof.

balanced load

An alternating, current power system consisting of more than two current carrying conductors in which these current carrying conductors all carry the same current.

billing demand

The demand level that a utility uses to calculate the demand charges on the current month’s bill. Various methods may be used to determine the value, such as minimum demand, peak demand or a ratchet clause. It can be based on Watt Demand, VA Demand, VAR Demand or some combination of these. A rate at which a transmission occurs, where one baud equals one bit per second.

broadcast

Broadcast address is a value used for performing commands on all Modbus slaves that are connected on the network. Slave address 0 is reserved for this value.

burden

The electrical load placed on source of VA or the load an instrument or meter places on a current or potential transformer. All current and potential transformers have a rated burden which should not be exceeded or else transformer transformation accuracy deteriorates.

capacitor

A device consisting essentially of two conducting surfaces separated by an insulating material or dielectric. A capacitor stores electrical energy, blocks the flow of direct current, and permits the flow of alternating current to a degree dependent upon the capacitance and frequency. They may also be used to adjust the power factor in a system.

coil

This is a Modbus mapped location used for reading and writing bit length data. These bits typically reflect the value of the discrete outputs. Powermonitor 3000 does not support this data type.

connected load

The total load which a customer can impose on the electrical system if everything was connected at one time. Connected loads can be measured in horsepower, watts or volt-amperes. Some rate schedules establish a minimum demand charge by imposing a fee per unit of connected load.

current transformer (CT)

A transformer, intended for measuring or control purposes, designed to have its primary winding connected in series with a conductor carrying the current to be measured or controlled. CT's step down high currents to lower values which can be used by measuring instruments.

current transformer ratio

The ratio of primary amperes divided by secondary amperes.

data table

Powermonitor 3000 data is organized in data tables similar to those found in an SLC 5/03 Programmable Controller. The detailed data table definitions are covered in Appendix A of the "Bulletin 1404 Powermonitor 3000 User Manual".

demand hours

The equivalent number of hours in a month during which the peak demand is fully utilized. In other words, if energy consumption for the current month is X kwhr and the peak demand is Y Kw, then the demand hours is equal to X/Y hours. The higher the number of demand hours, the better the demand leveling situation, and the more effectively demand is being used.

demand interval

Demand charges are based on peak demand over a utility specified time interval, not on the instantaneous demand (or connected load) at any given moment. Typical demand intervals are 15, 20, and 30 minutes.

discrete input

This is a Modbus mapped location used for reading bit length data. These bits typically reflect the value of the discrete inputs. Powermonitor 3000 does not support this data type.

exception reply

This is the Reply Packet for a Modbus Command that was unsuccessful in operation.

frequency

The number of recurrences of a periodic phenomenon in a unit of time. In electrical terms, frequency is specified as so many Hertz (Hz) where one Hz equals one cycle per second.

function code

Function byte: second byte of any Modbus COmmand packet.

holding register

This is a Modbus mapped location used for reading the writing word length data. For a Powermonitor 3000 slave device, the locations are defined by the Modbus Memory Map.

horsepower (hp)

A unit of power, or the capacity of a mechanism to do work. It is equivalent to raising 33,000 pounds one foot in one minute. One horsepower equals 746 watts.

impedance

The total opposition (i.e., resistance and reactance) a circuit offers to the flow of alternating current at a given frequency. It is measured in ohms.

induction motor

An alternating current motor in which the primary winding (usually the stator) is connected to the power source and induces a current into a secondary (usually the rotor).

inductor

A device consisting of one or more windings with or without a magnetic core. Motors are largely inductive.

initiator pulses

Electrical impulses generated by pulse-initiator mechanisms installed in utility revenue meters. Each pulse indicates the consumption of a specific number of watts. These pulses can be used to measure energy consumption and demand.

input register

This is a Modbus mapped location used for reading word length data. For a Powermonitor 3000 slave device, the locations are defined by the Modbus Memory Map.

lagging current

The current flowing in an AC circuit which is mostly inductive. If a circuit contains only inductance the current lags the applied voltage by 90 degrees. Lagging current means lagging power.

leading current

The current flowing in a circuit which is mostly capacitive. If a circuit contains only capacitance the current leads the applied voltage by 90 degrees. Leading current means leading power factor.

load

Any device or circuit consuming power in an electrical system.

load shedding

The removal of load from the line to limit load and control demand level.

load restoring

The energizing of loads that were previously removed from the line to limit load and control demand level.

Modbus

Industrial communication network protocol created by the Modicon Corporation.

neutral

The conductor chosen as the return path for the current from the load to the source. It is also a voltage reference point in a power system.

ohm

The unit of electrical resistance. One ohm is the value of resistance through which a potential difference of one volt will maintain a current flow of one ampere.

peak demand

The highest average load over a utility specified time interval during a billing period. If there is no ratchet clause in the rate schedule, then the peak demand is also the billing demand.

polyphase

Having or utilizing several phases. A polyphase power circuit has several (typically three) phases of alternating current with a fixed phase angle between phases.

potential transformer (PT)

An transformer with the primary winding connected in parallel with the circuit whose voltage is to be measured or controlled. PT's are normally used to step down high-voltage potentials to lower levels acceptable to measuring instruments. Also known as voltage transformer (VT).

potential transformer ratio

The ratio of primary voltage divided by secondary voltage.

power factor

The ratio of real power in watts of an alternating current circuit to the apparent power in volt-amperes. Also expressed as the cosine of the phase angle between the fundamental voltage applied to a load and the current passing through it.

power factor correction

Steps taken to raise the power factor by closely aligning the current to be in phase with the applied voltage. Most frequently this consists of added capacitance to increase the lagging power factor of inductive circuits.

power factor penalty

The charge utilities impose for operating at power factor below some rate schedule-specified level. This level ranges from a lagging power factor of 0.80 to unity. There are innumerable ways by which utilities calculate power factor penalties.

ratchet clause

A rate schedule clause which states that billing demand may be based on current month peak demand or on historical peak demand, depending on relative magnitude. Usually the historical period is the past eleven months, although it can be for the life of the contract. Billing demand is either the current month peak demand or some percentage (75 percent is typical) of the highest historical peak demand, depending on which is largest. It is designed to compensate the electric utility for maintaining equipment not fully utilized.

reactance

The opposition to the flow of alternating current. Capacitive reactance is the opposition offered by capacitors and inductive reactance is the opposition offered by an inductive load. Both reactances are measured in ohms.

real power

The component of apparent power that represents real work in an alternating current circuit. It is expressed in watts and is equal to the apparent power times the power factor.

resistance

The property of a substance which impedes current flow and results in the dissipation of power in the form of heat. The unit of resistance is the ohm. One ohm is the resistance through which a difference of potential of one volt will produce a current of one ampere.

revenue meter

A meter used by a utility to generate billing information. Many types of meters fall in this category depending on the rate structure.

root mean square (RMS)

The effective value of alternating current or voltage. The RMS values of voltage and current can be used for the accurate computation of power in watts. The RMS value is the same value as if continuous direct current were applied to a pure resistance.

RTU

Remote Terminal Unit, one of two possible transmission formats supported by Modbus. Powermonitor 3000 only supports RTU slave function.

slave address

This is the numerical label for slave devices. Valid slave device addresses are in the range of 0 to 247 decimal. The individual slave devices are assigned addresses in the range of 1 to 247. The value of 0 is reserved for broadcast.

sliding demand interval

A method of calculating average demand by averaging the average demand over several successive short time intervals, advancing one short time interval each time. Updating average demand at short time intervals gives the utility a much better measure of true demand and makes it difficult for the customer to obscure high short-term loads.

sub function code

Sub function word: third and forth bytes of any Modbus Command packet.

unbalanced load

A situation existing in a three-phase alternating current system using more than two current carrying conductors where the current is not due to uneven loading of the phases.

volt-ampere (VA)

The unit of apparent power. It equals volts times amperes regardless of power factor.

volt-ampere demand

Where peak average demand is measured in volt-amperes rather than watts. The average VA during a predefined interval. The highest average, i.e. Peak VA demand, is sometimes used for billing.

voltage (V)

The force which causes current to flow through a conductor. One volt equals the force required to produce a current flow of one ampere through a resistance of one ohm.

watt (W)

A measure of real power. The unit of electrical power required to do work at the rate of one joule per second. It is the power expended when one ampere of direct current flows through a resistance of one ohm. Equal to apparent power VA times the power factor.

watt demand

Power during a predetermined interval. The highest average, i.e. Peak demand is commonly used for billing.

watt hour (Whr)

The number of watts used in one hour. Since the power usage varies, it is necessary to integrate this parameter over time. Power flow can be either forward or reverse.

wattmeter

An instrument for measuring the real power in an electric circuit. Its scale is usually graduated in watts, kilowatts, or megawatts.

volt ampere reactive hours (VARH)

The number of VARs used in one hour. Since the value of this parameter varies, it is necessary to integrate it over time. VARs can be either forward or reverse.

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